House of Commons

Defence Committee

The contribution of Unmanned Aerial Vehicles to ISTAR capability

Thirteenth Report of Session 2007–08

Report, together with formal minutes, oral and written evidence

Ordered by The House of Commons
to be printed 15 July 2008

HC 535
Published on 5 August 2008
by authority of the House of Commons
London: The Stationery Office Limited
£0.00

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Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) is a key military capability and is fundamental to Network Enabled Capability (NEC). Unmanned Aerial Vehicles (UAVs) have emerged as an important means of collecting ISTAR information. The capabilities of UAVs have increased significantly in recent years and the pace of change is likely to increase in line with technological advances. The United States has made substantial investment in UAV technology. The Ministry of Defence (MoD) was perhaps slow to appreciate the potential of UAVs, but now recognises the important contribution they can make.

The MoD has acquired UAVs for current operations as Urgent Operational Requirements. The acquisition of UAVs such as Reaper and Hermes 450 are providing our Armed Forces with "battle winning capabilities", and are proving effective in the counter-insurgency style of operations which they face in Iraq and Afghanistan. In addition to collecting ISTAR information, a UK Reaper UAV has fired its weapon system in support of coalition forces in Afghanistan.

The MoD is acquiring the Watchkeeper UAV system which should provide significant capability improvements. The programme is currently forecast to be delivered within the approved cost and to the planned in-service date of 2010.

There are a wide range of challenges, some of which are international or cross-departmental, which have to be addressed in order to exploit fully the benefits offered by UAVs. Key challenges include bandwidth—which is under increased pressure from the increasing amounts of ISTAR information being collected and disseminated—and issues relating to airspace and air traffic control. The MoD is seeking to identify solutions to these challenges, but must ensure that the impetus is maintained.

At the start of 2008 the Army had a 48% deficit in UAV operators, although the MoD says that the deficit has had no impact on operational theatres. UAVs are collecting increasing amounts of imagery, in particular through the use of Full Motion Video. To optimise the value of the imagery collected the MoD requires imagery analysts. There is currently an 18% deficit in imagery analysts in the RAF. The MoD must address the manning deficits in these areas in order to gain the maximum value from its current and future UAV systems.

The MoD has acquired a range of UAVs which collect ISTAR information. However, improvements are required in how the information collected is processed and disseminated. Two major programmes—Defence Information Infrastructure and DABINETT—are expected to deliver these improvements. It is vital that they are delivered to the planned timetable so that the ISTAR information collected can be fully exploited.

The Defence Industrial Strategy (DIS) of December 2005 and the Defence Technology Strategy of October 2006 both acknowledged the importance of capabilities and technologies relating to ISTAR and UAVs. UK industry is considered to be world class in a number of areas relating to UAVs, such as some sensor technologies. It is crucial that the MoD ensures that the updated version of the DIS is published without further delay so that those parts of industry working in high technology areas, such as those relating to ISTAR

and UAVs, are provided with the clarity they require about future work and where they need to invest.

UAVs are only one approach to collecting ISTAR information and only one element of ISTAR capability. Given the importance of ISTAR, the Defence Committee plans to undertake further inquiries into this key military capability.

1 Introduction

1. ISTAR (Intelligence, Surveillance, Target Acquisition and Reconnaissance) is a key military capability that generates and delivers specific information and intelligence to decision makers at all levels in support of the planning and conduct of operations. At the lowest tactical level it consists of individuals using their eyes and reporting what they see. At the strategic level it involves the collection, analysis and dissemination of a complex range of information from maritime, land, air and space-based platforms. The ISTAR process is fundamental to Network Enabled Capability.[1]

2. ISTAR is a broad subject and includes the co-ordinated direction, collection, processing and dissemination of timely, accurate and relevant information and intelligence. Given its importance, the Committee plans to undertake a series of inquiries into ISTAR. Our first inquiry focuses on the contribution of Unmanned Aerial Vehicles (UAVs) to ISTAR capability. The Ministry of Defence (MoD) has acquired a number of UAV systems as Urgent Operational Requirements (UORs) and is also acquiring the Watchkeeper UAV system, which is expected to enter service in 2010. Our inquiry examined a range of issues relating to UAVs and ISTAR, including: how the UAVs acquired for current operations are performing and the lessons being identified; the progress on the Watchkeeper programme; and the MoD's future plans for exploiting the ISTAR capabilities offered by UAVs. UAVs are used primarily as collectors of information and intelligence. During our inquiry we also examined some of the factors that are limiting the most effective use of the ISTAR information collected.

3. We held three oral evidence sessions. The first oral evidence session was on 6 May 2008 with Air Vice-Marshal Simon Bollom, Director General Combat Air; Air Vice-Marshal Stuart Butler, Capability Manager Information Superiority; and Air Vice-Marshal Chris Nickols, Assistant Chief of the Defence Staff (Operations). The second oral evidence session was on 13 May 2008 with representatives from UK industry / UK defence trade associations. The third oral evidence session was on 3 June 2008. At this session we took evidence from representatives of Thales UK, the prime contractor for the Watchkeeper programme, and from representatives of Northrop Grumman, a global defence and technology company with a long history of providing UAVs to military customers, particularly in the United States.

4. We received written evidence from the MoD, defence companies and others.[2] We are grateful to all those who contributed to our inquiry including our specialist advisers.

1 *Delivering Security in a Changing World – Future Capabilities* (Cm 6269) published in July 2004 states that: "NEC is about the coherent integration of sensors, decision-makers and weapon systems along with support capabilities. NEC will enable us to operate more effectively in the future strategic environment through the more efficient sharing and exploitation of information within the UK Armed Forces and with our coalition partners. This will lead to better situational awareness across the board, facilitating improved decision-making, and bringing to bear the right military capabilities at the right time to achieve the desired military effect.", para 2.1

2 Ev 48-87

2 ISTAR: an overview

What is ISTAR?

5. Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) was described in outline to us in the MoD's memorandum:

> ISTAR is a key military capability that generates and delivers specific information and intelligence to decision makers at all levels in support of the planning and conduct of operations. The ability to convert information into intelligence that decision makers can act upon is a crucial aspect of the capability. ISTAR can be characterised as the co-ordinated direction, collection, processing and dissemination of timely, accurate, relevant and reliable information and intelligence. This process is of course fundamental to Network Enabled Capability and specifically, for example, to targeting and the integration of military effects, situational awareness (and hence Combat Identification and the minimisation of the risk of fratricide) and force protection. Complex terrain and agile adversaries, for example, increase the requirement for capable ISTAR.
>
> ISTAR capability can be generated at all levels of military operations. At the lowest tactical level it consists of individuals using their eyes and reporting what they can see, so equipping them with binoculars and a radio can significantly improve capability. At the strategic level it involves the collection and analysis of a complex range of information from maritime, land, air and space-based platforms. Low level tactical ISTAR assets (for example, thermal imagers) are organic to maritime, land and air formations where ISTAR is secondary to other functions such as targeting.[3]

ISTAR and Network Enabled Capability

6. The MoD's memorandum states that the ISTAR process is "fundamental to Network Enabled Capability".[4] The importance of Network Enabled Capability (NEC) was set out in the Defence White Paper *Delivering Security in a Changing World* published in December 2003:[5]

> NEC is crucial to the rapid delivery of military effect. The SDR [Strategic Defence Review] New Chapter recognised NEC as being fundamental in countering terrorism abroad, with its ability to deliver precise and decisive military effects, with unparalleled speed and accuracy through linking sensors, decision-makers and weapons systems…. It relies on the ability to collect, fuse and analyse relevant information in near real-time so as to allow rapid decision making and the rapid delivery of the most appropriate military force to achieve the desired effect. In addition therefore to the provision of a digitised communications network itself, we must also ensure that the appropriate sensors are available to gather information and

3 Ev 48

4 *Ibid*

5 Ministry of Defence, *Delivering Security in a Changing World Defence,* Defence White Paper, Cm 6041-I, December 2003

> that our forces have the appropriate reach and deployability to achieve rapid effect…. Through NEC the command structure will improve its responsiveness to events on the ground and have the flexibility to respond in near real-time to fleeting targets, even where higher-level decision making is required prior to engagement.[6]

7. *Delivering Security in a Changing World—Future Capabilities* was published in July 2004 as a supplement to the Defence White Paper *Delivering Security in a Changing World* and set out some of the equipment programmes, such as the Watchkeeper UAV, which would contribute to NEC:

> Within the next five years there are several major programmes which will contribute to the high capacity network required to support NEC: Skynet 5 delivers the next generation of military satellite communications services to support all UK operations; Cormorant will link the strategic satellite based communications with operationally deployed headquarters, and Falcon will provide a secure communication system at the operational level; Bowman meets tactical voice and data communications needs. Building on these foundations, the Defence Information Infrastructure will provide the capability to exchange and share electronic information across Defence from foxhole to stores depot and from sensor to shooter. Elsewhere in the network, the MoD is continuing to invest in developing stand-off sensors, such as Watchkeeper, an Unmanned Air Vehicle and improved electronic warfare capabilities such as Soothsayer. The recently trialled ASTOR airborne surveillance system will meet the Army and RAF requirement for surveillance, reconnaissance and target acquisition information, as well as providing the UK's contribution to NATO's Alliance Ground Surveillance project. Improved stand-off sensors will not, however, remove the requirement for timely and accurate human intelligence (HUMINT), particularly in the field at the operational and tactical levels. We intend, therefore, to provide additional deployable HUMINT teams.[7]

8. In its memorandum to our Defence Equipment 2008 inquiry, the MoD stated that nearly 60% of the current 500 or so projects in the equipment plan could be described as "significant contributors in some way to NEC". The MoD's memorandum provides a list of some of the key programmes, which include:

- **Defence Information Infrastructure** (DII)—This network is being rolled out in the fixed sites in the UK. An initial capability has been approved to extend to deployed HQs at a cost of some £370 million for delivery in 2008–09. An initial top secret capability is being considered for deployment shortly afterwards. Decisions have not yet been made on the remaining requirement for deployed, fixed and top secret capability.

- **DABINETT**—This programme is currently in the concept phase and intends to deliver a system of systems to address our future Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) requirements. DABINETT aims to address two distinct

6 Ministry of Defence, *Delivering Security in a Changing World Defence,* Defence White Paper, Cm 6041-I, December 2003, para 4.7

7 Ministry of Defence, *Delivering Security in a Changing World Future Capabilities*, Cm 6269, July 2004, para 2.3

but related capability gaps—the ability to undertake deep and persistent surveillance of the battlefield and the ability to manage the intelligence cycle efficiently from end to end. Given its wide scope, DABINETT plans to adopt a programme approach with individual projects or groups of projects managed within an overall programme framework. Delivery is likely to be incremental and include a combination of existing and future platforms and sensors, support centres and links to intelligence systems.

9. The memorandum also sets out the most significant challenges that needed to be addressed to deliver NEC and the likely timescale for meeting the NEC "Maturity States". It states that "a 3-Star Senior Responsible Owner has been appointed in recognition of the significance of NEC as a Defence priority."[8]

10. We asked what progress the MoD was making with NEC. Air Vice-Marshal (AVM) Butler said that in some areas progress was "extremely good", but in other areas it was "more of a challenge". He considered that overall progress was "pretty good". He added that:

> We would clearly always like to move faster but, within the constraints of the financial situation that any organisation finds itself in, it is given its relative priority, and we are constantly assessing, as you know, over time, about where we put our investment.[9]

11. **Network Enabled Capability (NEC) is a key future defence capability. In its response to our Report we expect the MoD to provide us with an update on the progress being made to address the challenges to delivering NEC and the latest estimates of when the NEC Maturity States are expected to be achieved. NEC is an area we plan to monitor closely.**

Broad categories of ISTAR capability

12. The MoD considers that the Armed Forces have available to them a wide range of ISTAR capability covering all operating environments. Output from ISTAR is used extensively in Joint Operations. Current ISTAR capability can be broken down into three broad categories—Strategic, Operational and Tactical. Examples of the main equipment systems under each of the categories are set out below:

- **Strategic**—examples of the main equipment systems include: the Fylingdales site which provides early warning of ballistic missile threats to the UK and is an integrated part of the US global early warning network; and the Nimrod R1 system which currently provides manned airborne electronic surveillance.

- **Operational**—examples of the main equipment systems include: the Sea King Mk 7 Airborne Surveillance and Control (SKASaC) helicopter system which can operate off naval platforms or land and provide air and surface surveillance using a mix of electronic, radar and electro-optic sensors; and the Raptor reconnaissance pod system for Tornado GR4 aircraft which provides long range ground surveillance.

8 Defence Committee, *Defence Equipment 2008*, Tenth Report of Session 2007-08, HC 295, Ev 38

9 Q 4

- **Tactical**—examples of the main equipment systems include: the Scarus man-portable system and the vehicle mounted INCE and Odette systems which provide electronic surveillance for land forces.[10]

The ISTAR "chain"

13. The MoD's memorandum explained that "conceptually, ISTAR is delivered through two distinct but inter-related capability areas". The two areas are:

- **The collection side**—which aims to provide capabilities that can gather accurate and timely information across the environments and can detect, track and identify enemy, neutral and friendly entities within a defined area, day and night, and in all weathers.

- **The direction, processing and dissemination side—**which aims to provide capabilities that can direct collection effort and then process and disseminate derived information and intelligence to all levels in national and coalition operations.[11]

14. At our evidence session with MoD officials, AVM Butler referred to "the ISTAR chain which is direct, collect, process, disseminate".[12] He explained that:

> direct is really all about trying to prioritise the intelligence and surveillance needs of a commander on the battle field. So, what does he need to know, by when in a particular area? So that is direct, and then turning that into how we task the collectors that will then go out to collect that intelligence surveillance information. Collect is obviously the bit where, whatever type of collector it is goes out to hoover up that information, albeit whether it is an airborne platform or whether it is a ground sensor, or whatever it needs to provide the information that the commander needs, that information then comes in as raw data and then that need to be processed to form an intelligence product, and then the dissemination bit is how that is transmitted to the war fighter, and that war fighter may well be a single troop in the field or it may well be somebody working back here in defence intelligence, for example. So it is whoever needs that information to effectively gain information superiority which gives us the upper hand on any potential enemy. If you regard it as that DCPD chain, that is ISTAR in a nutshell, which, of course, the UAV platform fits into the collect but, of course, we have to consider it end to end, because unless all four bits of that chain work, the commander does not get the information he needs when he needs it.[13]

UAVs and ISTAR

15. Unmanned Aerial Vehicles (UAVs), usually called Unmanned Aerial Systems (UASs) in the United States (US), have emerged as an important means of collecting ISTAR

10 Ev 48-49

11 Ev 50

12 Q 2

13 *Ibid*

information. They have become increasingly capable and, compared with manned platforms, are well suited to missions / tasks involving the 4 Ds:

- **Dull**—missions / tasks which require persistence or repetition over days, weeks or months.
- **Dangerous**—missions / tasks which carry a high degree of risk.
- **Dirty**—missions / tasks which are carried out in hazardous environments.
- **Deep—**missions / tasks which are beyond the range of tactical manned platforms.[14]

16. UAVs are one possible solution to the collection part of ISTAR capability. The MoD acknowledges that, given the ability of UAVs to undertake missions / tasks involving the 4 Ds, they:

> are therefore often seen, when equipped with Full Motion Video (FMV) and in some cases radar and other sensors, as the right solution to ISTAR collection requirements at the Theatre/Operational, Formation/Higher Tactical, and Lower Tactical levels.[15]

17. AVM Butler told us that UAVs were "an extremely important part of the collect" part of the DCPD chain, but for a "UAV to work it must be a system and must fall within the DCPD chain, because a platform on its own just collecting the data is worthless".[16] The Defence Technology Strategy (DTS) published in October 2006 notes that UAV is increasingly referred to as UAS (Unmanned Aerial System) to reinforce the concept that the platform is "just one component of the wider integrated system, including payload and sensors, but particularly the communications and control environment within which the platform has to be integrated".[17] In our report we have generally used the term UAV, although we recognise that the UAV platform is only one part of a wider system.

18. Our inquiry into ISTAR focuses primarily on the current and future contribution of UAVs to improving ISTAR capability.

14 Ev 66

15 *Ibid*

16 Q 5

17 Ministry of Defence, *Defence Technology Strategy for the demands of the 21st century*, October 2006, para B9.36

3 ISTAR: the contribution of UAVs

The increasing capability and importance of UAVs

19. The increasing capability and importance of UAVs were highlighted in the memoranda submitted to our inquiry and examples are provided in Table 1 below.

Table 1: Examples from the memoranda received of the increasing capability and importance of UAVs

The increasing capability and importance of UAVs
"in 1998 a UAV crossed the Atlantic for the first time, covering 3270 kilometres in 26 hours and 45 minutes using a gallon and a half of fuel…. boundaries around aircraft effectiveness and efficiency had been shattered by this exciting new technology, which offered the potential to greatly reduce the exposure of aircrew to risk and to greatly expand military ISTAR capabilities"—Intellect.[18]
"Unmanned Air Vehicles (UAVs) have a major contribution to make to the aerial surveillance component of…. (ISTAR) capability…. Have performance characteristics unmatched, or not matched cost effectively, by manned aircraft including persistence…. agility, and the ability to operate from rudimentary take off and landing sites"—Thales UK.[19]
"UAVs are transforming the battlefield in Iraq and Afghanistan. Future conflicts will see their role expanded dramatically. In war-fighting situations, they offer shortened target engagement timescales compared to conventional platforms. For peacekeeping and peace enforcement missions, they offer vital persistent ISTAR capabilities"—Northrop Grumman.[20]
"a UA can climb, dive and turn faster and more tightly than manned aircraft…. giving them superior aerobatic capabilities. This has led to the US Air Force to call for Unmanned Combat Aircraft Systems (UCAS), which are confidently predicted to outperform future manned combat aircraft in the next decade or two"—Royal Aeronautical Society.[21]
"over 39 countries have developed or are developing UAVs of varying sizes and with varying levels of technical sophistication. A 2005 census revealed some 400 UAV programmes in existence or under development"—Royal Aeronautical Society.[22]

20. The Global Hawk UAV provides a good illustration of the increasing capability of UAVs. John Brooks, President of Northrop Grumman Inc. told us that:

> One Global Hawk is capable of searching the entire State of Illinois in a single mission. That may not be terribly useful to you and perhaps I could offer that the combination of England and Wales are about the same volume as the State of Illinois; or, to put it in a operational context, if we think back to the horrific tsunami

18 Ev 61

19 Ev 69

20 Ev 77

21 Ev 57

22 Ev 56

> in the South Pacific of a few years ago, one Global Hawk is capable of surveilling the entire region affected by that tsunami in one mission.[23]

Ed Walby, Business Development, HALE Unmanned Systems, Northrop Grumman added:

> in terms of the capability of the sensors…. it actually has the ability to image every square inch of the territory [the example of Illinois], not just survey it.[24]

21. The NATO Joint Air Power Competence Centre (JAPCC) acknowledges the importance of UAVs:

> Today we have in our hands a completely new capability that allows commanders to project power in every way we may imagine through the use of unmanned systems…. the increased demand for UAS in NATO is being fostered by the large variety of tasks that UAS may perform such as precision target designation, communications and data relay, mine detection and a host of other missions. We can say that UAS are changing the way commanders conduct military operations.[25]

22. Northrop Grumman's memorandum notes that within the US Armed Forces the use of UAVs is already widespread, "while, in the UK, the MoD has made UAVs a strategic priority".[26] The Royal Aeronautical Society considers that the MoD and the UK armed services were "perhaps slow to appreciate the potential of unmanned systems and the value of UAS operations is only beginning to be recognised in MoD and only in specialised areas". However, it acknowledges that:

> it is evident from the Afghanistan deployment and commitment of research funds to technology acquisition in this area and the general awareness of UAS is very much better than before and improving at a pace. The Society believes that ISTAR is one of the specialised areas where UASs are being taken seriously and that MoD ISTAR planning has been and is being further reassessed as a result of UAS experience.[27]

23. We asked if the UK had been slow in recognising the benefits of UAVs. John Brooks, said that he had no expertise to comment on the MoD's progress, but he pointed out that in the US "we have benefited from some period of time and some very large investments of dollars which have enabled us to field some of the advanced capabilities". He considered that, given the close relationship between the two countries, the UK "has the ability to capitalise on these investments". [28] Victor Chavez, Vice President, Business Development, Sales and Marketing, Thales UK, told us that the US had invested more than any other country in strategic UAV systems such as the Reaper and Global Hawk systems. However, he considered that "If you look at the middle level, where we see Watchkeeper and the

23 Q 231

24 *Ibid*

25 *The Joint Air Power Competence Centre (JAPCC) Flight Plan for Unmanned Aircraft Systems (UAS) in NATO*, 10 March 2008, page 3

26 Ev 77

27 Ev 56

28 Q 229

Hermes 450, the country that has invested more and has greater operational experience of that than almost anywhere is Israel".[29]

24. **The capabilities of UAVs have increased significantly in recent years and the pace of change is likely to continue in line with technological advances. The United States in particular has made substantial investment in UAV technology. We note that the MoD has recognised the important contribution that UAVs can make, particularly in relation to ISTAR.**

UAVs acquired as UORs

25. ISTAR collection requirements in Iraq and Afghanistan are being delivered through a layered approach using manned and unmanned platforms. MoD see this as a model for the future.[30] In addition to in-service ISTAR assets, a number of additional capabilities have been provided as UORs over recent years to address specific capability gaps in current operations in Iraq and Afghanistan. The MoD's memorandum states that "For the period 2003–07 the emphasis has been on improving the ability to collect ISTAR against an increasingly agile and ISTAR-aware adversary."[31] Details of the key UAVs acquired by the MoD as UORs for current operations are provided in Table 2 below.

29 Q 198

30 Ev 52

31 Ev 49

Table 2: Key UAVs acquired by the MoD as UORs for current operations

Key UAVs acquired by the MoD as UORs
Reaper (formerly Predator B)—This Theatre/Operational level UAV system came into service in autumn 2007 to meet an Urgent Operational Requirement (UOR) for persistent ISTAR in Afghanistan. Reaper is a large UAV weighing about 4,500kg and with a wingspan of 20m. It carries a FMV sensor and a Synthetic Aperture Radar (SAR) with Ground Moving Target Indication (GMTI) capability. It also carries a laser range finder and designator. It has an operational endurance of approximately 16 hours[32], and can fly at up to about 240 knots. UK military personnel[33] fly the mission using beyond-line-of-sight satellite communications operating from a Ground Control Station (GCS) at Creech Air Force Base, Nevada USA. Take-off and landing of the UAVs in theatre is accomplished by a launch and recovery element manned by a mix of US and UK military personnel using line-of-sight communications. A total of two air vehicles and one GCS have been deployed to Afghanistan. A third UAV is due to be delivered in mid 2008 and a second GCS later in 2008. Planned enhancements include electronic surveillance and weaponisation of the UAV with multiple Hellfire missiles and GBU 12 precision guided bombs to improve prosecution of time-sensitive targets. **Hermes 450—**A Formation/Higher Tactical level UAV capability was procured as a UOR and entered service from July 2007. The capability is provided as a service by Thales UK using the Hermes 450 UAV system. The air vehicle is launched by a contractor-provided external pilot and operated throughout the mission phase by Royal Artillery personnel, with control handed back to the contractor for the recovery and landing. Servicing and support are the contractor's responsibility. Hermes 450 is a medium-sized UAV that weighs about 450kg and has a wingspan of about 10.5m. It has an endurance of around 14 hours, but must remain in radio line-of-sight of the GCS. It operates at slower speeds and lower altitudes than Reaper. Up to 10 air vehicles and 6 GCS are being used, providing FMV ISTAR support in Iraq and Afghanistan with two concurrent missions possible in both theatres. **Desert Hawk 3**—DH3 is a Lower Tactical level UAV system procured under UOR procedures in 2007. It is a hand-launched system that has an endurance of around 60 minutes. A total of 18 systems (144 air vehicles and 18 GCS) have been deployed in both Iraq and Afghanistan providing FMV ISTAR support to Battlegroup operations and below. The capability is operated by Royal Artillery personnel embedded in Battlegroups. A further five systems are being procured.

Source: MoD[34]

26. We asked why the requirement for the UAVs acquired as UORs had not been identified earlier. AVM Butler told us that "in many cases they were identified earlier". The Hermes 450 UAV was acquired as a "stop-gap" filler because the Phoenix UAV system could not be operated effectively in a hot and high climate. The MoD had "a follow-on to Hermes 450 in terms of the Watchkeeper programme, which was already well established before…. the UOR provision of Hermes 450". The MoD already had in their plans the requirement for "a deep and persistent surveillance capability…. so arguably Reaper is filling a gap that we had already identified" and will be a contender for "that longer term programme". For Desert Hawk, he said that:

> when we looked at the assessment of what we could get on time with the right process and dissemination capabilities, again it filled the gap adequately and we went in to buy it. In the slightly longer term, particularly based on the experience we are

32 With crosswind limits and the lack of diversion ability of UAVs, operational flying is limited to around 11 hours so that 5 hours of fuel is kept in reserve in order to keep the UAV airborne if necessary.

33 39 Squadron RAF, working closely with Joint Force personnel in theatre.

34 Ev 66-67

> getting with Desert Hawk, we will look at how we fill that capability gap in the future.[35]

27. At our evidence session on 13 May 2008 with representatives from UK defence trade associations, Clive Richardson representing Intellect told us that ideally the UK would have had its "own platforms and our own programme but that has not been funded over the years". Industry recognised the need to acquire UAV systems as UORs. However, Simon Jewell, representing the Society of British Aerospace Companies (SBAC), stressed that the use of UORs to acquire UAV systems should not become the strategy to provide the capability in the longer term. SBAC would like to see:

> the balance being maintained between developing national capability and supporting UOR capability for urgent operational requirements.

David Barnes representing the Unmanned Aerial Vehicles Society (UAVS) of Great Britain considered that:

> there is a danger, and the danger is in pursuing UORs and keeping them in service for a long time we will undermine our national capability to develop and deploy.[36]

28. **The MoD has acquired UAV systems for current operations as Urgent Operational Requirements (UORs). In its response to our Report, we expect the MoD to set out its future plans for the UAV systems acquired as UORs and where the future costs fall within the defence budget. We also expect the MoD to set out its longer term strategy for acquiring UAVs systems, given the concern expressed by industry that keeping the UAV systems acquired as UORs in service for a long time could undermine the UK's national capability in this area**.

Different roles of UAVs on current operations

29. The UAVs acquired as UORs for current operations vary substantially in size:

- Reaper weighs some 4,500 kilogrammes and has a 20 metre wingspan;
- Hermes 450 weighs some 450 kilogrammes and has a 10.5 metre wingspan;
- Desert Hawk is hand-launched.[37]

30. The MoD acknowledges that the varied needs of each level of command could be met by a single platform type, but considers that the capability "would need to be driven by the most demanding requirement (long range, long persistence, very capable sensors). This could lead to disproportionate cost, delayed timelines and, at lower levels, excessive capability."[38] We sought clarification on the roles / tasks undertaken by the different UAVs on current operations. Chris Day, Business Executive, UAV Systems, Thales UK, provided the following overview:

35 Q 8

36 Q 115

37 Ev 66-67

38 Ev 52

> there is a lot of activity going on by the guys in the infantry who are walking the ground who actually want to know, in very quick time, what is immediately ahead of them. That really means they have got to have command and control of it themselves. They have got to be able to hand-launch it. He wants to know what is 200 metres down that road; so he hand-launches his little UAV and within 25–30 seconds he knows what is ahead of him. That is what the mini UAV gives him. It gives him an ability to have command and control, and for him to actually be able to use that air vehicle to gain that information extremely quickly; but it places constraints on the system. It means it has to live with the infantry, the guys who are actually walking the streets on the operation. He cannot push around a 450 kilogram air vehicle; he needs something that can live in his pack—and that is where minis come from. When we are talking about operations in urban environments, built-up areas, little mini UAVs are absolutely the right thing to have. The key message to get across there is the mini UAVs can normally have a daylight sensor, just like normal televisions at home, or a thermal imager; they cannot have both. They do not have the ability to lift both sensors. If it is night-time you have got to sit there, break it apart and put a thermal on it. If it is daytime you put the TV on it. The other thing is, because they are model airplanes, and if any of you have seen model airplanes fly, they are not very stable; so the imagery is not particularly good, but it gives you the snapshot, and it gives you that bit of information that may make a difference.

He added that:

> the big driver for moving from minis, to slightly larger platforms…. is all about the quality of the imagery and the range at which we can operate it. Now we are talking about a sensor that is very stabilised, that can sit and look at my face for 12 hours of the day; it can move very quickly through the environment, perhaps a speed of 100 knots, perhaps less. The little minis do 30 or perhaps 40 knots so they are a lot slower. The big platform also has the ability to carry other sensors, and the one I would like to talk about is something we call "synthetic aperture radar". What that really means, it is a radar that gives us an image that looks pretty much like something you would see on a television; it gives you an image. The real attraction is, when there is cloud most television cameras cannot see through cloud—no ability at all; you can leave your air vehicle on the ground—cloud, fog or mist, no capability at all. You put synthetic aperture radar on it and it sees through cloud; it gives the guys a clear image of everything that is stationary on the ground. We then link it to another bit of technology that allows us to see everything that is moving on the ground. Those radars weigh about 40 kilograms as a minimum…. I need a larger platform to lift it in the air…. I cannot do that with a mini; I need a bigger platform. You can start to see that the critical variable with UAVs—that is the air vehicles themselves—is the more payload you want, the larger the air vehicles…. The more sensors you want, the more capability, the larger the general platform. The other driver that links to things the Americans do is they like to fly higher. Little mini UAVs, those poor little television sensors, they are only good from about 300 or 400 feet to a 1,000 feet above the ground; if you fly higher than that imagery is not very good. You might say, "I want to fly at 5,000 or 10,000 feet", but you need a better sensor, so you move into the Hermes system. If you have then got a very large platform like the Predator, the Reaper or the Global Hawk, they operate at

> significantly higher altitudes, and one of the reasons is they carry a very significant sensor suite. They have to operate higher in order to keep them safe. Those are the sorts of variables which define where you pitch your UAVs.[39]

31. Victor Chavez emphasised that another key variable in relation to UAVs was persistence, the ability to "remain on-task for very extended periods of time". If there was a need to watch one location "for 24 hours a day", this could not be done with a mini UAV. For such tasks it was important for the UAVs to remain undetected which required it to be at an altitude where is was not visible and could not be heard. Again, this could not be achieved with a mini UAV. [40]

Performance of UAVs on current operations

32. Hermes 450 UAVs are operating in both Iraq and Afghanistan and Reaper UAVs only in Afghanistan. We asked how effectively the UAVs acquired as UORs had performed on current operations. AVM Butler considered that Hermes 450 and Reaper UAVs "have done extremely well and they have been battle winning capabilities beyond a shadow of a doubt". AVM Nickols added that:

> for the style of operations, particularly the counter-insurgency style of operations, the ability to loiter over an area for very long periods, which allows you to watch what we call "pattern of life" so you can build up a picture of what is happening in a particular location is one of the great needs and, of course, that is one of the great strengths of a UAV and that is why they have been so successful. The other point to make perhaps in counter-insurgency, which goes back to an earlier question, is that they very much need to be intelligence-led. You can only find the insurgents through comprehensive intelligence, and that is why the wider ISTAR architecture, including the UAVs, is so important in this style of operations.[41]

33. The performance of UAVs on current operations was referred to in several of the memoranda submitted to our inquiry. Intellect's memorandum states that "the UOR programmes have brought immediate and vital benefits, delivering assets into theatre within a short timescale and enabling increased force protection via improved ISTAR capability".[42]

34. **The MoD has acquired UAVs as Urgent Operational Requirements (UORs) for current operations in Iraq and Afghanistan. These UAV systems, such as Hermes 450 and Reaper, are providing "battle winning capabilities" and are proving effective in the counter-insurgency style of operations which our Armed Forces are involved in.**

39 Q 207

40 *Ibid*

41 Q 10

42 Ev 62

Reaper

35. Reaper UAVs are procured from and operated from the US. AVM Butler acknowledged that the UK was "very heavily dependent" on the US, but told us that the situation was "not uncommon, and we are across quite a lot of our collectors". He added that the issue was about affordability and "to do it all in-house would be unaffordable". On the specific issue of operational sovereignty, he said that:

> So, where there is a logical fallback and a sensible fallback and where we need to retain UK sovereignty, we seek to do so, but generally we are fairly comfortable in my arena working closely with the US particularly.[43]

He set out how the current operating arrangements with Reaper worked and the advantages to the UK:

> at the moment, because it is a strategic asset and it is easier to link it into the air space control and the command and control piece, we actually operate it effectively over exactly the same system that the US operate it on, and again there is significant advantage by us being closely coupled with the US in the strategic environment because it makes things like tasking—we get the information from the totality of the Reaper system rather than just our own.[44]

36. The UK was "almost entirely free" from the US in terms of how its Reaper UAVs were maintained. There were advantages to the UK in relation to upgrades as, if the US upgraded their Reaper UAVs, the UK "get the advantage of being able to buy into that at a relatively low cost". The same was true if the US upgraded the Reaper ground stations. AVM Butler added that "there has been a transition phase that we have gone through where we have relied very heavily on the US, but we are slowly coming away from that".[45]

37. In terms of operational control over the deployment of Reaper UAVs, the UK had "entire freedom as to where we task them".[46] The US had no veto over how the UK used its Reaper UAVs and the UK did not have to inform the US where they were being deployed.[47] AVM Butler stressed that Reaper UAVs are a theatre asset and "are allocated on a theatre basis". He added that the UK did "not actually dictate where they are operated. They are operated against the highest theatre need, and bear in mind the people that decide that are both UK and US". AVM Nickols highlighted the advantages of this approach:

> the benefit we get from putting them into this pool of assets is that, given that our area, particularly in Afghanistan, is one of the busiest areas, we gain more than we lose from that. We get more ISTAR out of the system than we, UK Limited, contribute to the system.[48]

43 Q 39

44 Q 40

45 Q 41

46 Q 42

47 Qq 43-44

48 Q 45

38. **The UK's Reaper UAVs, acquired from the US, are operating in Afghanistan. They are delivering vital ISTAR capability at the Theatre/Operational level and the procurement of a US system has provided substantial advantages to the UK. The MoD has assured us that the UK retains operational sovereignty over its Reaper UAVs—it can maintain, upgrade and use them independently. This is an issue we plan to monitor closely. In its response to our Report, we expect the MoD to set out what issues might arise relating to operational sovereignty and the UAV systems procured from the US if the UK/US Defence Trade Cooperation Treaty is not ratified.**

39. On 6 June 2008, the MoD announced that an RAF Reaper UAV had, for the first time, used its weapon system in support of coalition forces in Afghanistan.[49] The issue of armed UAVs is considered later in our Report (paragraphs 141-143).

Hermes 450

40. The memorandum from Thales UK states that "in June 2007, Thales was awarded a UOR contract by the UK MoD to provide UAV systems to support UK forces on current operations…. Thales' swift response enabled the first in-theatre delivery to be achieved on 14 June 2007. First flight was on 20 June 2007 and Initial Operating Capability (IOC) was declared on 5 July 2007".[50] We asked what capability the Hermes 450 UAV system was delivering on current operations and what feedback had been received from our Armed Forces. Chris Day provided the following overview:

> we have now achieved somewhere in the region of about 9,000 operational hours…. We support the MoD across a whole range of different types of operation. When we entered the journey, pretty much just over a year ago, the targets were tough and very difficult to meet; we had about six months to get this capability up and running, the regiment trained and ready to deploy; and more specifically, which has been one of the key areas that we have learnt probably most about, is the logistic support that we need in order to support our guys out in both theatres; and we have picked up an awful lot of information associated with that. We have to work closely with the guys because, at the end of the day, they are using it on average for about 14 hours a day—that is two air vehicles up each day for about 14 hours a day, every day of the year—sometimes for durations of 100 hours consistently.

Nick Miller, Head of UAV Systems, Business Development, Thales UK added that;

> Feedback from operations have said that this is extremely advanced, and an enhancing capability. It provides full motion video; and an electro-optic and infra-red camera is onboard the unmanned vehicle, and provides that video and intelligence throughout the battlespace command for the land-based commander, both through forward air controllers, through remote viewing terminals or laptops, but also into the ground infrastructure in both theatres. So it is providing that battle-winning capability with electro-optic infra-red intelligence.[51]

49 Ministry of Defence website, Defence News, 6 June 2008, *RAF Reaper fires weapons for first time*

50 Ev 70

51 Q 200

41. We sought further details on how the Hermes 450 UAV system was actually benefiting troops on the ground. Chris Day explained they had a remote video terminal—"a manned, portable television screen with a simple antenna", which gave them "a clear view of what is going on in compounds…. a clear view of what is going on over the hill…. a clear view of what is around the corner… a clear view before they actually enter that building".[52]

42. **We commend Thales UK for the speed at which it delivered the Hermes 450 UAV system to our Armed Forces in Iraq and Afghanistan following the award of the UOR contract. The system is providing vital high quality ISTAR information to our troops on the ground**.

Lessons learned from current operations

43. We examined the broad lessons learned from operating the UAVs acquired as UORs on current operations.

Areas which could be improved

44. UAV systems include platforms, sensors, data links and ground control stations and we asked which of these areas could be improved. AVM Butler considered that all of these aspects could be improved, but the MoD probably needed to concentrate more on the direct, process and disseminate parts of the chain as "generally in collection terms now we are getting reasonably good". He added that "you can always improve on all of them. It is just that the DPD is probably the bit where we need to make slightly more effort now than we have done hitherto".[53]

45. **We note that, from the experience of current operations, the MoD is broadly content with the assets it has, such as UAVs, which collect ISTAR information. However, the MoD considers that further improvements are required in relation to the Direct, Process and Disseminate elements of the ISTAR chain.**

46. We asked what the MoD was doing to improve the Direct, Process and Disseminate elements of the ISTAR chain and what specific programmes would deliver these improvements. AVM Butler said that:

> If you look across my portfolio, the vast majority are stand-fast areas where we are simply updating collectors to keep them current and operationally viable. The vast majority of what I am doing in my area is based around the DPD effort. For example, we have got one of the biggest IT programmes in Europe currently running with DII, which will enable us to move information across the battlefield[54], and we have a programme in the slightly longer-term called DABINETT, which is effectively joining up the dots.[55]

52 Q 206

53 Q 11

54 DII will work with communication bearer systems such as Bowman and Skynet 5 to achieve this.

55 Q 12

The National Audit Office (NAO) report *Ministry of Defence: The Defence Information Infrastructure* was published on 4 July 2008.[56] The NAO reports that throughout 2005 and early 2006 problems emerged with two key elements of the programme which have "caused major delays to the rollout of the first stage of the DII Programme". The end date for the installation of Increment 1 of DII is "running 18 months late against the estimated latest completion date at contract signature".[57]

47. **Our inquiry has focused on UAVs and their contribution, primarily as collectors of ISTAR information, to current and future ISTAR capability. The MoD has a number of key programmes, such as Defence Information Infrastructure and DABINETT, to improve how the ISTAR collection effort is directed and how the intelligence and information collected is processed and disseminated. In its response to our Report, we expect the MoD to provide us with an update on the progress made to date on these two key programmes. We plan to examine the Direct, Process and Disseminate elements of the ISTAR chain in future inquires into ISTAR.**

48. We examine the issue of exploiting the ISTAR information collected in Part 4 of our Report (paragraphs 105-111).

UAV losses on current operations

49. The Royal Aeronautical Society's memorandum notes that UAVs are largely invisible and inaudible from the ground, which "when combined with persistence makes them a formidable capability especially over difficult and hostile terrain". However, should the platform be identified by the enemy:

> it is potentially more vulnerable to counter measures as reaction to ground fire may be slower, and the system intrinsically less able to evade hostile action.[58]

50. On 23 April 2008, it was reported in the media that the RAF had destroyed a Reaper UAV which had crash landed in Afghanistan.[59] The MoD recognises that UAV operations involve a degree of risk and some losses can be expected. The MoD's memorandum provides the following details of UAV losses on current operations:

- On 9 April 2008 a Reaper air vehicle made a forced landing in southern Afghanistan. Sensitive items were recovered and the remaining wreckage destroyed. The forced landing was being investigated and mechanical issues were suspected. The MoD was seeking to replace the UAV.
- A Hermes 450 air vehicle crashed during an attempted landing in difficult weather conditions in Iraq in January 2008.

56 National Audit Office, *Ministry of Defence: The Defence Information Infrastructure*, HC 788 Session 2007-2008

57 *Ibid*, para 8

58 Ev 56

59 "RAF destroys £10m spy plane in Afghanistan", *Daily Telegraph*, 23 April 2008

- As at the end of February 2008, 27 Desert Hawk mini-UAVs have been lost over the previous 12 months.[60]

51. **We recognise that when UAVs are operating in hostile environments some losses can be expected. It is essential that the risk of such losses is minimised, particularly in relation to the large UAVs such as Reaper which carry sensitive payloads. In its response to our Report, we expect the MoD to set out the lessons identified from the UAVs lost on current operations, how it plans to address them, and to update us on the number of UAV losses.**

Contracting arrangements

52. In acquiring UAVs for current operations, the MoD has taken a different approach to traditional procurement methods. Intellect's memorandum states that:

> Some of the UAS UOR programmes have strayed from the traditional asset acquisition model of procurement: both the Hermes 450s and the Desert Hawks are provided as a managed service, where the MoD is procuring 'ISTAR by the hour'. This alternative—and overtly capability based—model may provide useful lessons for the future delivery of UAS".[61]

53. The memorandum from Thales UK states that for the Hermes 450 UAV system the "UOR is being fulfilled by Thales through a highly innovative service provision contract ("ISTAR by the hour")…. The contract includes the provision of Hermes 450 UAV systems, as well training of the MoD staff in the use and maintenance of the system, and the provision of Contractor Logistic Support (CLS) and programme management services".[62]

54. **We note that for some of the UAVs acquired as Urgent Operational Requirements, the MoD is using new approaches to contracting such as "ISTAR by the hour". We welcome new approaches to contracting for defence equipment, particularly where such approaches improve reliability and availability. We look to the MoD to evaluate whether these new approaches are delivering the expected benefits and, if they are, to consider how they might be used more widely.**

Watchkeeper programme

55. The MoD's memorandum stated that "the only Defence funded programme to field an operational UAV capability is for the Watchkeeper tactical UAV system" and provides the following information about the programme:

> Main Gate approval was given in mid-2005. Watchkeeper is currently expected to reach Initial Operating Capability in the second half of 2010 and to reach Full Operating Capability in 2013. The system is being developed from the Hermes 450 system currently operating in Iraq and Afghanistan.The programme is due to deliver

60 Ev 67

61 Ev 62

62 Ev 70

(including attrition stock) 54 air vehicles and 15 GCS and will provide the capacity to conduct up to 12 concurrent missions (or "lines of tasking"). It will be operated by 32 Regiment Royal Artillery. Watchkeeper is intended to support Land operations and is capable of carrying simultaneously three types of sensor: electro optical/infra-red FMV; SAR [Synthetic Aperture Radar]; and GMTI [Ground Moving Target Indication]. In addition, it will carry a laser rangefinder/target marker. It will have UK-specific data links, have an automatic take off and landing capability and be able to use tactical landing strips. Overall, Watchkeeper provides greater capability compared to Hermes 450 and, subject to operational circumstances at the time, the intention is that it will start to take over from Hermes 450 from 2010.[63]

56. Thales UK is the prime contractor for the Watchkeeper programme. Victor Chavez told us that "Watchkeeper is absolutely state of the art" and he considered that "There is nothing in the States [US], I believe, that is significantly in advance of Watchkeeper…. even though it was based originally on an Israeli UAV design, the system components, the communication systems, the sensor systems and so on are derived on a best in class basis from around the world: the data links, for example, very important in terms of international interoperability, are bought from the US; the radar system is being manufactured by Thales in the UK".[64]

Progress against approved cost and in-service date

57. The Major Projects Report 2007 provides details of the progress of the programme against the approved cost and in-service date which are set out in Table 3 below.

Table 3: Progress of the Watchkeeper programme against the approved cost and in-service date

	Cost £ million	**In-Service Date**
Approved at Main Gate	920	February 2011
Current forecast	901	June 2010
Variation	-19	-8 months

Source: National Audit Office[65]

58. In its memorandum, Thales UK stated that the programme is on track for the planned in-service date of 2010. The most recent milestone was the successful first flight of the Watchkeeper air vehicle which took place on 16 April 2008.[66] AVM Butler told us that the MoD was "fairly hopeful that we will get something in towards the end of 2010, all things being equal".[67] Nick Miller informed us that following the first flight of the air vehicle, the

63 Ev 67

64 Q 198

65 National Audit Office, *Ministry of Defence Major Projects Report 2007, Project Summary Sheets*, HC 98-II, Session 2007-2008, 30 November 2007, pp 164-165

66 Ev 71

67 Q 58

company was "now starting the integration phase and current testing" and the programme would be ready for the 2010 in-service date.[68]

59. **We note that the Watchkeeper UAV programme is currently forecast to be delivered within the approved cost and to the planned in-service date. We look to the MoD to identify the factors which have resulted in the good progress to date on this programme and how they could be applied on other equipment programmes.**

Additional capabilities offered by Watchkeeper

60. We asked how different the Watchkeeper UAV system would be from the Hermes 450 UAV system. AVM Butler said that the Watchkeeper system would bring many of the capabilities currently on the Hermes 450 "but better because clearly it is a longer term programme". It will have have:

> better rough-field landing characteristics; it will have better sensors because they will be better integrated and they will be a better system, so it is a significant advancement over the current Hermes 450.[69]

61. We followed up this issue with the witnesses from Thales UK. Nick Miller said that there were two elements of Watchkeeeper which were different from Hermes 450:

> There are the advancements in the air vehicle itself; and of course there is the network ground infrastructure…. The air vehicle itself is a dual payload configuration, so it can take the EO/IR camera as well as the radar together—electro-optic and infra-red—and additionally a more sophisticated SAR GMTI radar. It has an all-weather operational capability; so it has de-icing systems built in. It has got enhanced structure integrity with an adapted wing fuselage construction. Autonomous flight capability and auto take off and landing. Of course, the additional maintenance and access to subsystems is improved. The advanced duplex avionics on board and the enhanced landing gear.. So there are many aspects within the air vehicle of a significant difference. On the ground infrastructure side you have got the exploitation, communication dissemination that we discussed as a fundamental difference of the Watchkeeper system; and of course dual data links; the ability to pass information securely around the battle space. All this is required because Watchkeeper has got to provide a worldwide capability. Armed Forces can be deployed anywhere in the world and in climate conditions that are different from current theatres. Of course it has got the ability to be flexible for additional operational sensors in the future. You can see we have built into the growth future of Watchkeeper not only the air vehicles but also the ground network enabled infrastructure.[70]

62. We sought further information on the additional capabilities which Watchkeeper would provide in terms of the dissemination of ISTAR information. Nick Miller explained that:

68 Q 212

69 Q 56

70 Q 211

> The Hermes 450 system is basically a collector at the moment of image intelligence, and provides the basis of that intelligence to the land component. What Watchkeeper brings as a system is much more of a dissemination, communication and network system. What we are learning from the Hermes 450 is how we grow that path towards the full integrated system where the information is passed throughout the intelligence. Hermes is a collector; is providing the right imagery, down to the right ground operator at the right time; but the next step forward is to pass that information to all the necessary players across ground infrastructure, across air vehicles, across all the different land component commanders. There is a difference between the collector system of Hermes and the Watchkeeper system of the future; which is why the ground infrastructure is so important in Watchkeeper.[71]

63. In its memorandum, Intellect states that "programmes already in development—notably Watchkeeper—show that the next generation of UAVs will offer substantial technological improvements over current models".[72]

64. **We note that, when it enters service, the Watchkeeper UAV system should provide substantial advancements over the Hermes 450 UAV system both in relation to the air vehicle and the ground network enabled infrastructure.**

Sovereign capability

65. We have taken a close interest in the issue of sovereign capability relating to defence equipment programmes. It has been a central issue on the Joint Strike Fighter (JSF) programme, which we have examined in a number of our inquiries. Sovereign capability is about the UK being able to maintain, upgrade and use equipment independently. The vehicle for Watchkeeper is derived from the Hermes 450 which was developed by an Israeli company.[73] We asked whether the UK would have sovereign capability in relation to Watchkeeper when it entered service. John Howe, Vice Chairman, Thales UK explained that the vehicle for Watchkeeper was being developed and produced in the UK in a joint venture with Elbit, an Israeli company. Victor Chavez told us that:

> right at the outset of Watchkeeper MoD placed upon us some fairly stringent requirements in terms of sustainability of supply of all aspects of the system in the UK, because obviously we wanted to ensure that the UK had ownership of the intellectual property associated with all aspects of that; and hence the creation of the joint venture, which is based in the UK, to manufacture and to own and to hold that IPR for the air vehicle.[74]

66. We asked whether the UK would be able to maintain and upgrade Watchkeeper independently. Victor Chavez said "absolutely" and explained that this was the reason why they had created a joint venture in Leicester which holds the intellectual property. John

71 Q 205

72 Ev 64

73 Q 198

74 *Ibid*

Howe added that "Watchkeeper is being built in the UK, whereas Hermes 450 is an Israeli project".[75]

67. **The air vehicle for the Watchkeeper UAV system is derived from the Hermes 450 which was developed by an Israeli company. We note that a UK joint venture for Watchkeeper has been created and will hold the intellectual property. Thales UK assured us that the UK will have sovereign capability relating to the Watchkeeper UAV system**.

75 Q 217

4 UAVs: challenges to be addressed

Challenges

68. There are a wide range of challenges to be addressed to ensure that the significant benefits offered by UAVs, particularly in relation to improving ISTAR capability, are delivered. A number of these were identified in the memoranda submitted to our inquiry. A list of some of the key challenges are set out in Table 4 below.

Table 4: Key challenges to be addressed relating to UAVs and ISTAR

Key challenges to be addressed
Bandwidth and Frequencies
Airspace and Air Traffic Control
UAV operators and imagery analysts
Service issues
Operating with allies
Exploiting the information collected

Bandwidth and frequencies

69. The NATO Joint Air Power Competence Centre Flight Plan for Unmanned Aircraft Systems identifies a range of problems relating to UAVs. Problems relating to Bandwidth and Frequencies were assessed as "Urgency: Very High" as:

- Bandwidth: "There is not enough bandwidth to support current UAS operations".
- Frequencies: "There are no dedicated frequencies for UAS. There are no international standard frequencies for UAS operations, like there are for aircraft operations".[76]

70. We asked the MoD how critical the problems relating to bandwidth and frequencies were to the operation of UAVs. AVM Butler outlined the issues relating to bandwidth and how the MoD was seeking to address them:

> There are two issues largely with the UAV, one is the command and control route, i.e. how you tell the UAV to move around and how you tell it where to move and the other is the dissemination of the data. The first one is very simple: you have to almost have a 24/7 link while the thing is airborne because you need to be able to command it…. I have to say it is not a major user of the bandwidth doing the command and control. The bigger issue is the issue of disseminating the data, and the data can be very hungry in terms of bandwidth particularly if you are trying to do real-time full-

76 *The Joint Air Power Competence Centre (JAPCC) Flight Plan for Unmanned Aircraft Systems (UAS) in NATO*, 10 March 2008, page 24

> motion video, for example. Again, wherever we can as we develop the capability, we are looking both nationally and internationally at how we can minimise that issue, and that can be done via a whole variety of means. For example, in the Watchkeeper era we were not necessarily getting into full-motion video all the time, it will be frame at a time at set intervals. Equally, we are looking at what is the best way to disseminate the information. If you transmit a picture over the Internet, for example, you can transmit it in a number of different formats. What we are looking at is what is the format that uses the absolute minimum bandwidth transmission to get it over the system. Again, we are looking at a lot of techniques as to how to do that. The other thing is we engage in the World Radio Conference to make sure that the military bandwidth that we require is allocated to us, and then we use it in the most effective manner, because of course we have to pay for bandwidth now, as you may well be aware. A number of things are coming together which minimise the bandwidth problem.

Another way of saving bandwidth was having platforms which "can store and analyse the data on board and they do not need to push all of the information they collect down to the ground" AVM Butler stressed that the MoD was "very bandwidth conscious".[77]

71. On the issue of frequencies, the MoD made great efforts to ensure that the frequencies it used were allocated to it. However, in Iraq the MoD does not control the frequency usage and "the sovereignty of the bandwidth relies on the host nation country". AVM Butler said that he would:

> be the first to say it has caused us problems in the past, and one of the things we have learned is when you put a system into a theatre you really need to have dialable bandwidth, so if the one you are attempting to use is not a good one you can move the dial a little bit and transmit on another one. Dynamic bandwidth management is something we are becoming increasing[ly] adept at.[78]

72. The issue of bandwidth was also a major technology challenge for the US. John Brooks told us that technology provided the "ability to collect non-stop persistently across all of the spectrums essentially day and night, good weather and bad, imagery and electronics and signals and, therefore, something has to be done to make that useful. The current approach is largely a push approach to collect it and push it into the system where it can be dealt with. That means we have to expand the bandwidth available." He considered that the approach for the future should include both some technology that allows greater volumes of information to be pushed across the bandwidth and tools and procedures that made more effective use of the bandwidth available.[79]

73. **UAVs are collecting increasing amounts of ISTAR information, in a range of different formats, which is then disseminated to users. This is putting increasing pressure on the available bandwidth. The MoD is alert to this issue and is "bandwidth conscious". In its response to our Report, we expect the MoD to provide us with a**

77 Q 75

78 Q 76

79 Q 259

summary of how it is seeking to address the issue of bandwidth and its assessment of the progress being made.

Airspace and Air Traffic Control

74. In its memorandum, the Civil Aviation Authority (CAA) set out the issues relating to UAVs and Airspace and Air Traffic Control:

> The long term industry aspiration is that UAVs will be permitted to fly in exactly the same airspace as manned aircraft. An essential prerequisite will be that UAVs will need to meet all existing safety standards applicable to manned aircraft, which are appropriate to the class of airspace within which they are intended to operate. However, this will not be permitted until the UAV industry can demonstrate that UAVs have an 'equivalent' capability to manned aircraft in a number of respects, including safety. Airworthiness of the aircraft is an issue being monitored by the CAA's Safety Regulation Group. In airspace terms, the critical issue will be the development of a technical solution replicating the ability of a pilot of a manned aircraft to see and avoid other aircraft. The latter requirement has yet to be overcome and therefore, for the time being UAV flights that take place beyond line of sight[80] are restricted to such airspace as can be segregated from other airspace users. The operation of UAVs must also be transparent to the ATC [Air Traffic Control] system which means that an air traffic controller providing a service should expect a UAV to react to control instructions in the same way as would a manned aircraft. To date, the impact of UAVs on UK airspace and Air Traffic Control has been minimal; however, there are clear indications that the demand for segregated airspace is on the increase, both from UK industry and from the MoD.[81]

75. We asked the MoD how issues relating to airspace and Air Traffic Control impacted on the operation of UAVs. The MoD told us that:

> Current national and international regulations require UAVs to comply with exactly the same 'Rules of the Air' as manned aircraft. In practice the requirement to see and avoid other air users cannot currently be satisfied by any unmanned platform and for this reason all UAV operations in the UK (civil and military) are restricted to segregated airspace; in practice this constrains MoD UAV flying to military danger areas. In Iraq and Afghanistan, the airspace is under coalition military control so UAVs can operate more freely, although their operations need to be carefully organised, for example through restricted operating zones and air traffic management. Defence is part of a wider initiative to review regulations for UAV flying. Under arrangements led by the Assistant Chief of the Air Staff, the MoD is closely involved with the development of procedures and regulations to allow UAVs to operate in national and NATO airspace. These collaborative efforts involve engagement with NATO, European Defence Agency and Civil Aviation Authority

80 Beyond line of sight is considered to be a range exceeding 500 metres from the operator and/or 400 feet above ground level.

81 Ev 75

and are intended to form the basis for agreement to support global solutions for UAV systems.[82]

76. The MoD was seeking to address the challenges by "engaging with a number of national and international organisations that are developing the 'Sense and Avoid' regulatory framework that will, in time, allow industry to develop technology that could allow UAVs to operate in non-segregated airspace". [83] AVM Butler said that the MoD was engaged in a number of programmes, "not least of which is ASTRAEA", which are seeking to identify solutions, both nationally and internationally.[84]

77. The importance of the ASTRAEA programme was highlighted in a number of the memoranda submitted to our inquiry and examples are provided in Table 5 below.

Table 5: Examples from the memoranda received highlighting the importance of the ASTRAEA programme

The ASTRAEA programme
"BAE Systems formed the £32M UK ASTRAEA programme along with its fellow funding partners (Department of Trade and Industry (now DBERR), Welsh Development Agency (now WAG), North West Regional Development Agency, South East England Development Agency, South West England Regional Development Agency, Scottish Enterprise, EADS UK, Rolls-Royce, Thales, QinetiQ, Flight Refuelling and Agent Orientated Software. MoD supports ASTRAEA in an observer role and is being encouraged to become a full partner as a significant gearing to all parties could be achieved if knowledge and investment from the MoD were to be included. ASTRAEA investment is focussed on technology development, regulatory understanding and system demonstrations to achieve the goal of achieving the routine, non-segregated operation of UAVs in UK's airspace. From the success to date, further investment is being considered that would take the non-military investment to a total of £64M; of which Industry will have contributed £32M"—BAE Systems.[85]
"Thales is a key player in the UK ASTRAEA (Autonomous Systems Technology Related Airborne Evaluation and Assessment) programme…. Current manned aircraft regulations assume the presence of an on-board pilot and so ASTRAEA is investigating and developing technology solutions to perform equivalent functional performance while working with the regulators to interpret and develop appropriate guidance and regulations"—Thales UK.[86]
"The future prospect of the opening of non-segregated airspace to unmanned autonomous aircraft is a critical factor in the development of autonomous capabilities. For UAVs to be routinely used in place of manned aircraft, particularly in the civil sector, the current regulatory framework (as defined by the Civil Aviation Authority) will need to be re-interpreted to enable UAVs to operate alongside manned aircraft. The ASTRAEA programme is intended to pave the way for the integration of UAVs into non-segregated airspace within the next decade and is currently approaching the end of its first phase. A follow-up to ASTRAEA will be necessary to ensure that this work continues; its successful conclusion is likely to have a direct impact on the ability of industry in the UK to provide MoD with leading-edge autonomous technologies in the coming decades. It will also be critical if UAVs are to make a major contribution to supporting national security in the UK"—Society of British Aerospace Companies.[87]

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78. Simon Jewell is Chairman of the Steering Board for the ASTRAEA programme and provided the following details about the funding:

> It has currently committed £32.4 million of which industry is spending £16.2 million over a three year period. That money runs out at the end of this year and we are looking to launch the second conclusive phase of the programme. We are looking to raise a further £44 million of which industry will submit half, £22 million, over the next three years. That is not under contract but something we are moving towards. ASTRAEA does not have any MoD money at all.[88]

He told us that they were looking for the MoD to commit resources into the next phase of the programme "as part of their commitment to achieve the goal. The goal would be that by three years hence, at the end of this year, we would have the ability to go forward to the Civil Aviation Authority and certificate for safe operation in the UK air space".[89]

79. In its memorandum, Northrop Grumman highlighted the potential benefits of developing solutions relating to UAVs and airspace:

> The culmination of efforts to integrate full sense-and-avoid capabilities into UAVs will open the way for UAVs to migrate into civilian roles and applications. These will include disaster relief, crowd control, anti-terrorism surveillance, maritime search and support to the coastguard, police, fire and intelligence services.[90]

80. **UAV operations in the UK are restricted to segregated airspace as they cannot currently satisfy the requirement to see and avoid other air users. We note that the MoD is working with national and international organisations on this issue. In its response to our Report, we expect the MoD to set out why it supports the ASTRAEA programme only in an "observer role" and its future plans with regard to this programme. We see UAVs, when permitted to operate in the same airspace as manned aircraft, as playing a major role in operations relating to both civil and national defence.**

Watchkeeper

81. The CAA memorandum notes that in terms of military UAV flying within the UK, the prime activity is for training. At the present time this is confined to existing Danger Areas. However, it was recognised that with the future introduction of the Watchkeeper UAV:

> the size of the Danger Area complex in the vicinity of Salisbury Plain would not allow the UAV to utilise its full ISTAR capabilities due to the standoff range required for its sensors, i.e. the capability to operate at range from their intended target. As such, a proposal has been put forward by the MOD to establish additional Danger Areas to the south of the existing Salisbury Plain Training Areas. The Airspace Change Process is being conducted in accordance with CAA policy as set out in Civil Aviation Publication 725. Whilst this will clearly have an impact on other airspace

88 Q 140

89 Q 193

90 Ev 79

> users, full consultation will take place with, amongst others, the aviation community to ensure that the available airspace can be used in a safe and efficient manner and that the new Danger Area structure is proportionate to the MoD's needs and has the minimum impact on other airspace users.[91]

82. On the issue of operating Watchkeeper, the MoD's memorandum stated that: "A small number of proposals to adjust current airspace arrangements are being taken forward through the civil authorities. The main one relates to an Airspace Change Proposal (ACP) to increase the airspace available to UAVs around the Salisbury Plain Training Areas".[92] AVM Butler told us that the MoD would like to operate Watchkeeper over Salisbury Plain because, in terms of routine training, that is where the Army units were operating. However, if the proposal to increase the airspace available to UAVs around Salisbury Plain was not successful, the MoD had "fallback options" including "a number of danger areas in the US" that it could use.[93]

83. At our evidence session with representatives from Thales UK, we asked whether the issue of operating the Watchkeeper UAV over Salisbury Plain was likely to delay the programme. John Howe said it was significant issue, but he did not consider that it was "a clog in the process". He thought that is was being "addressed sensibly and very methodically and thoroughly, and we will get through the process".[94]

84. On 17 June 2008 the MoD announced that is was undertaking public consultation on proposals to extend the existing airspace used by UAVs above Salisbury Plain in Wiltshire. The MoD press notice states that:

> The proposal includes an additional area to the south of the plain. The extension to the airspace is being sought because the increasing sophistication of the Unmanned Aerial Vehicles used by UK Armed Forces means that the current airspace is now insufficient to accommodate the full training requirement.
>
> The proposed new area of operation, bounded by Warminster, Andover, Stockbridge and Shaftesbury, would only be activated when required for training, predominantly during normal working hours. It would include additional airspace to provide separation from civil air traffic when activated.
>
> Following initial discussions with a number of organisations, the public consultation period will last until late September.

Watchkeeper is expected to be the first UAV to utilise the proposed airspace, which extends from 8,000 to 16,000 feet. The MoD acknowledges that the proposed new airspace "may affect a small proportion of the aviation community that currently uses this airspace".[95]

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91 Ev 76

92 Ev 69

93 Q 85

94 Q 216

95 "MoD announces public consultation on UAV airspace expansion", Ministry of Defence website, *Defence News*, 17 June 2008

85. **We note that the MoD has announced that it is undertaking a public consultation on proposals to extend the existing airspace used by UAVs above Salisbury Plain. We will wish to be kept informed of the outcome of the consultation and to be updated on the progress of the MoD's proposals. If the MoD's proposals are accepted, it will be important that appropriate procedures are put in place to ensure that any disruption caused by new airspace is kept to a minimum consistent with the requirements of defence and security.**

86. We were concerned about the risk of UAVs crashing, particularly when being operated over the UK. AVM Butler emphasised that the airworthiness regime that the MoD had to go through for UAVs was the same as for "ordinary fixed-wing aircraft".[96] He said that the "risk rates for flying your average UAV are broadly similar to a single-engined light aeroplane".[97]

UAV operators and imagery analysts

87. In the Government Response to our report on the MoD Annual Report and Accounts 2006–07, examples were provided of the pinch point trades in the Army and the Financial Retention Incentives introduced to help address them. One of the examples related to UAV operators and the details are set out in Table 6 below.

Table 6: Deficit in UAV operators in the Army and measures taken

Trade	Deficit October 2006	Deficit January 2008	Measures taken
Unmanned Aerial Vehicle operators	51%	48%	100% take-up on recently introduced £10,000 payment for three years return of service. The benefits will be seen in the future

Source: MoD[98]

88. We asked why the deficit in UAV operators in the Army was so large. AVM Butler told us that the deficit was no longer at that level and had improved considerably. He stressed that there was "no impact at all on the operational theatres". However, he added that "what we are doing on the odd occasion is stretching people a little bit much but we do not actually have a deficit for supporting current ops".[99]

89. Given that UAVs deliver imagery, we asked if there was a deficit in imagery analysts. AVM Butler said that the MoD was short of imagery analysts and confirmed that there was a deficit. He told us that:

> it is an area which is one of our pinch points. They are quite difficult to train, it is quite difficult to get the right people and at the moment we do not have as many as

96 Q 83

97 Q 86

98 Defence Committee, Fifth Special Report of Session 2007-08, *Ministry of Defence Annual Report and Accounts 2006-07: Government Response to the Committee's Fifth Report of Session 2007-08*, HC 468, p 9

99 Q 21

> we would like, but we are working through processes to ultimately get us up to the level that we need.[100]

90. The MoD subsequently provided us with the following information on UAV operators:

- At present, there is a recognised shortfall among trained senior UAV tradesmen.
- For current operations, using the Hermes 450 system, there is currently no shortfall of qualified personnel.
- The manning establishment of the Regiment [32 Regiment Royal Artillery] has recently been increased in preparation for the entry into service of the Watchkeeper UAV system which is planned to begin towards the end of 2010. If measured against this new establishment, the senior operator shortfall based on current manning levels would be around 70%. Over the next two years the Army will address this situation through normal manning processes, such as extra training courses and transferring personnel from trades where manning levels have been reduced to ensure that the new establishment is met…. If necessary, a range of extra measures, including Financial Retention Incentives (FRI), may be used to aid in recruitment and retention.
- RAF manning for UAV operations is currently broadly in balance. There is no current requirement for UAV operators in the Royal Navy.
- Overall, there is sufficient trained manpower to meet current operational requirements, albeit this has required, as elsewhere, a rebalancing of priorities and breaking harmony guidelines for some individuals.[101]

91. The MoD acknowledges that the increased use of Full Motion Video and the introduction of new collection assets has increased the requirement for imagery analysts. There is a shortfall of some 18% in imagery analysts within the RAF. In the short term this is being addressed through management of training, including the introduction of a new basic course on FMV. For the longer term, the position will be monitored and the MoD is developing an overall strategy "to make better use of this scarce resource, including work to understand better the recruitment and retention issues and whether the training course structure is right". A recruitment strategy is being implemented although this is not expected to provide additional imagery analysts for around two years. The MoD considers that manning in the other Services is broadly in balance. The MoD memorandum states that:

> Overall, there is sufficient trained manpower (with use of reserves) to meet current operational requirements but, as in other areas there has been a need to rebalance priorities.[102]

92. **The MoD needs the right number of UAV operators with the right skills to make maximum use of the UAV systems it has acquired and is in the process of acquiring. We are concerned to learn that there are substantial deficits in the number of UAV**

100 Q 32

101 Ev 86-87

102 Ev 87

operators in the Army and that the position may worsen when the Watchkeeper UAV system enters service at the end of the decade. We will wish to be updated on the success of the measures being taken to address the deficits in UAV operators. We note that the MoD considers that the deficit in UAV operators has had no impact on current operations.

93. **UAVs are delivering increasing amounts of imagery. In order to optimise the value of the imagery collected, the MoD requires sufficient imagery analysts trained in areas such as Full Motion Video. We are concerned that there is an 18% deficit in imagery analysts in the RAF and that a recruitment strategy which is being implemented is not expected to provide additional analysts for some two years. As with UAV operators, we will wish to be updated on the success of the measures being taken to address the deficit in this area.**

94. **We look to the MoD, in its response to our Report, to provide us with a list of the manning pinch points that impact upon the operation of UAVs, including those trades involved in supporting and maintaining UAVs. The list should set out the current deficits and the action in hand to address them.**

Service issues

95. In its memorandum, the Royal Aeronautical Society raised the issue of "UAS-ISTAR as a "purple" asset" and states that:

> Inter-service rivalry in the development and deployment of UAS-ISTAR assets is a persistent issue, certainly for the US military. However, while the current UK experience appears to be somewhat better the Phoenix was a Royal Artillery (RA) - sponsored project and was seen as a RA Reconnaissance and Target Acquisition system (possibly also with battle damage assessment (BDA) capability). Any suggestion that it might be used for surveillance and intelligence purposes was fiercely contested. In summary, the other challenge is a cultural and organisational need to take an enterprise level view of capability management. It is vital that the UK should continue to develop a cross-service approach to this asset, particularly for the wider battlespace and strategic perspective. Currently, the Reaper is operated by the RAF, while Watchkeeper will be deployed by the Army. While there is no reason to suppose that use of these assets and the data they obtain will not be well coordinated, the MoD should ensure that all UAV assets are developed and deployed according to an overall strategy for UAV-related activities.[103]

96. We asked why the RAF was operating Reaper UAVs and the Royal Artillery operating Hermes 450 and Desert Hawk UAVs. AVM Butler stressed that the important issue was where the product was delivered and "ultimately the product, irrespective of which UAV it comes from, is delivered predominantly to the fighting troops on the ground". The Reaper UAV was "more akin to an air force type strike aircraft" so the RAF was better placed as it was more experienced in that type of tasking. He added that:

103 Ev 57-58

> there is not, to my mind, the discrepancy or conflict between the different services because it is where it naturally falls in terms of what we do best.[104]

97. We were concerned about ISTAR information being lost between the different Services operating UAVs. AVM Butler said that it was "as seamless as things are in war time". In the case of the Reaper UAV the information went back to the US and was then disseminated to where it was needed. For other UAVs, the information was provided direct from the UAV to a small ground terminal which "the troops have in their hands—either a laptop or on-vehicle borne system".[105]

98. **We note that on current operations the RAF is operating the Reaper UAV and the Army is operating the Hermes 450 and Desert Hawk UAVs. The MoD has assured us that this approach has not caused any problems regarding the dissemination of ISTAR information, and that the focus has been on delivering what was required to the troops on the ground. In its response to our Report, we expect the MoD to set out its plans regarding which Service will have lead responsibility for future UAV systems and what consideration it has given to a joint UAV command.**

Operating with allies

99. The NATO Joint Air Power Competence Centre Flight Plan for Unmanned Aircraft Systems raises the following issues about using UAVs on operations:

> In defending against UAS operations, how will NATO ground forces know that the UAS above them is friendly and not an adversary's reconnaissance platform? Or worse, an adversary's armed UAV? How will ground based air defences know what they should fire at and what to let go. The first problem is to separate friend from foe. The second problem is that NATO's Air Defence systems might be more expensive than the threatening target to fire at or, that NATO's Air Defence stems may be saturated by sheer numbers of small, low-cost UAVs. How will we deal with these problems for the future?[106]

100. We raised the issue of identifying whether a UAV was friend or foe at the evidence session with MoD officials. AVM Butler explained how UAVs were tasked and that an air tasking order went out on a daily basis which "lets all of the other air users know where that particular platform is at any one time, and the way the system works". He said that:

> We also have systems already on the UAV to an extent which does an element of identifying where the platform is, so very similar to the ones we use in fixed-wing aircraft, and the final bit of that puzzle is what we call "sense and avoid", which is an area of technology we are working quite hard on to try and bring forward, but at the moment we do as much as we can to make sure we have got that deconfliction within the air space.[107]

104 Q 17

105 Q 18

106 *The Joint Air Power Competence Centre (JAPCC) Flight Plan for Unmanned Aircraft Systems (UAS) in NATO*, 10 March 2008, para 3.7.1.2

107 Q 36

101. In its memorandum, Northrop Grumman considered that "coordination among UAVs being used in theatre is critical to avoid redundancies, misinterpretation of facts on the ground, and radar interference".[108] The Royal Aeronautical Society considered that there was "good cooperation at many levels internationally and in the unmanned systems community generally, there is good sharing of common operational experience…. Bilateral, multilateral, NATO and EDA groups all share their experience, and the US-UK relationship has been particularly fruitful".[109] However, the NATO Joint Air Power Competence Centre Flight Plan for Unmanned Aircraft Systems states that "Integration of UAS is not occurring in NATO. Nations are developing stove-piped systems that do not integrate with each other nor with NATO networks". [110]

102. We asked about interoperability with allies in relation to UAVs. AVM Butler told us that:

> we are very much on key with the US. If you look at Reaper, for example, it is operated fundamentally over a US tasking system. On the wider issue of interoperability with other nations, we have number of fora where we get together, and I represent the MoD on many of them, where we have UAV focus groups to make sure that, as best we possibly can, we avoid any overlap of things like tasking, for example, and how we do command and control, and many of the other nations work very similar systems either to us or to the US. In actual fact, in theatre at the sort of tactical level there is not a problem because they tend to be supporting their own troops; at the strategic level we do tend to work it across a US/UK predominant battle space. So they tend to link in with us rather than us having to link in with them, but, as I say, there are a number of UAV groups that are together across both bilateral arrangements and "five eyes" and NATO arrangements where we are seeking constantly to make sure we are interoperable with other nations.[111]

103. We asked about the dissemination of ISTAR information on operations which could be being collected by different UAVs. AVM Butler told us that to the soldier on the ground with his laptop receiving images he "does not actually care whether it is Reaper or whether it is a Watchkeeper or whether it is a Canadian system…. he just wants his data, so providing the standards work, it does not really matter". AVM Nickols added:

> It is just worth making the point for instance in Afghanistan an awful lot of the UAVs are either Predator As, Reapers or Hermes 450 and the same ground terminal will accept the imagery from all three of those, whether they be UK, US, or indeed any other nation, so while there are still some problems with some systems we are tackling it and addressing the problem, particularly in the operational areas.[112]

104. **We note that there are arrangements in place to make sure that the UK's UAV systems are interoperable with those of other nations. In Afghanistan, the ISTAR**

108 Ev 79

109 Ev 58

110 *The Joint Air Power Competence Centre (JAPCC) Flight Plan for Unmanned Aircraft Systems (UAS) in NATO*, 10 March 2008, page 25

111 Q 38

112 Q 96

information is collected by Predator A, Reaper and Hermes 450 UAVs, but it can be processed by the same ground terminals. The MoD assured us that, while there were some problems with some systems, these were being addressed. We consider it vital that the MoD ensures that interoperability is a key requirement when acquiring future UAV systems.

Exploiting the ISTAR information collected

105. The MoD acknowledges that further improvements are required in relation to the Direct, Process and Disseminate elements of the ISTAR chain. Programmes such as DII and DABINETT are aimed at delivering the required improvements in the future (paragraph 8). Our inquiry focused on the contribution of UAVs, primarily as collectors of ISTAR information, to current and future ISTAR capability. However, issues about better exploiting the ISTAR information collected were raised in many of the memoranda we received. For example, the memorandum from Intellect states that "the exploitation (rather than solely the gathering) of information must be the focus of the UK's future development of ISTAR capability".[113] Intellect considers that:

> A bias towards the acquisition of increasing numbers of platform/collection assets…. runs the risk of consistently gathering vast mountains of data which cannot be analysed…. Intellect's members are aware of an analysis which claims that 80% of the ISTAR gathering in support of Operation TELIC took place to acquire material which had in fact been collected previously, but was either not accessible or not known to be available.[114]

106. In its memorandum, Thales UK considers that there is:

> a strong value for money argument for the Watchkeeper system to provide the basis for the UK based NEC Ground Infrastructure exploitation and dissemination capability as one of the key components to integrate the layered manned and unmanned ISTAR collector systems across the different layers of command for maximum UK Forces benefit.[115]

107. We asked how the Watchkeeper UAV system might provide this capability. Victor Chavez explained that:

> At the moment so much data is stored but it is not easily accessible; it is not easily catalogued; and it is accessible typically through one system. Watchkeeper provides a distributed information system where any number of users can access all of that data. Watchkeeper at the moment, the ground information infrastructure is really designed around the various sensors that are going to be on board Watchkeeper—the electro-optic cameras, the infra-red cameras and synthetic aperture radar; but there is nothing to stop that being extended to the information that comes off another UAV, a Reaper UAV, or off a Global Hawk UAV, or using different sensors. If you were to add in communications intelligence sensors or electronic support

113 Ev 64

114 Ev 63

115 Ev 72

> measures which detect signals, there is nothing to stop you actually using that information infrastructure to share that information. That would fulfill part of potentially the requirement known as DABINETT…. DABINETT is certainly one if not the highest priority ISTAR programming in the eyes of MoD; because at the moment MoD has got quite a lot of collectors of information but it has not got in place the infrastructure to really get best value out of that, and that is why there is such a high priority at the moment.[116]

108. The MoD acknowledges that the storage of information and intelligence and its analysis at later date is an area where improvements are needed. AVM Butler told us that:

> I think the one thing it may be worth putting our hands up about that we are not quite as good as we would like to be as yet is storage and analysis of that information at a later date; but you can imagine with something like Reaper, on task for something like 15 or 16 hours, there is an awful lot of data that we pull in and, again, it comes back to my earlier point: if we want to improve and we clearly do, then it is that type of thing that we would ultimately like to be able to get a better handle on.[117]

109. Dr Moira Smith, representing defence SMEs, considered it understandable that with the early UAV systems the focus was on the information they were able to gather rather than on the processing of that information. She said that there was now an emphasis "very much coming through from the MoD funding, to look much more at the data deluge problem".[118]

110. The need to improve the way the collection of information and intelligence was directed and the resulting data processed and disseminated was also an issue in the US. John Brooks told us that:

> these capabilities have to advance in harmony and that, as we demonstrated, the extraordinary power of persistence of a platform to not be episodic and pass over an area every great once in a while, but to maintain surveillance on a broad area for 24 or more hours, does place new demands, particularly on the exploitation system but also on the dissemination system, and it will require some level of manning and particularly some new tools to help automate that so that it can move forward. That is not to suggest that we should constrain our ability to collect down to what may currently be our ability to exploit…. We are moving in that direction but it does have to go forward in harmony so that you can capitalise on it.[119]

Ed Walby described an approach to tackling the issue during the operations in Afghanistan:

> what we were able to do as techniques were developed was we took an intelligence group and attached them to Global Hawk electronically in that as it collected and processed that imagery it was immediately exploited. Then as we progressed further

116 Q 221

117 Q 31

118 Q 118

119 Q 246

> we did some experiments on how we archive that information and now we are to the point where the information that is collected is archived, categorised and posted on secure websites for individuals to go and retrieve what they want to retrieve. The requirements of the collection may be dependent on a particular day but the information collected may be relevant to the next day's mission or the next hour's mission. All of that is at the hands of those throughout the distributed system who have access to those classified websites. We have even taken the server on board the aircraft which was the mission recorder and replaced it with a 1.4 terabyte server and connected that to a field radio so that a troop on the ground can literally reach up and pull and retrieve right off the Global Hawk. That is a capability that could be platform agnostic as well. Because of its altitude, Global Hawk tends to be a place that you can connect with other nodes. On the archival of that information, we flew a Global Hawk in combat for a year and collected every single image on that server and it only got to about 70 per cent full, so you have got the entire library of those images on board that system.[120]

111. **The MoD faces a major challenge to ensure that the systems which process and disseminate the ISTAR information collected keep pace with the systems which collect it. The MoD's progress in addressing this challenge is a matter we plan to examine in future inquiries into ISTAR.**

120 Q 246

5 UAVs: industrial issues and future requirements

Industrial issues

Defence Industrial Strategy

112. The Defence Industrial Strategy[121] (DIS) was published in December 2005. Section B8 of the DIS covers C4ISTAR (Command, Control, Communication and Computers, Intelligence, Surveillance, Target Acquisition and Reconnaissance) and states that:

> The ISTAR component constitutes a combination of sensors, weapons systems, IT hardware & software, people and processes that collectively enable the ISTAR cycle (Direct, Collect, Process & Disseminate). The technologies associated with these capabilities are often leading edge, draw extensively on research activities, exploit developments in the civil sector, and place a premium on innovation, rapid technology insertion and effective integration. It is this sector that the principle of spiral development to enable continued operational performance is most relevant given the rapid pace of technological development.[122]

113. The DIS states that in support of the forward programme of C4ISTAR capabilities, the ability to design and manufacture equipment does not generally need to reside in the UK. However, there is a need "to develop a cadre of system engineering skills to enable industry to understand our systems and in particular to support them through-life".[123] The DIS states that "in terms of technologies there are a number in which C4ISTAR are dependent, and in which there may, case by case, be a need for targeted investment to ensure a continued understanding of emerging developments or to have assurance regarding their security of supply". These technologies include: Data Fusion; Electro-Optic / Infra-Red Imaging; and Synthetic Aperture Radar. [124]

114. The DIS concludes that the C4ISTAR industrial sector is broadly in good health with significant potential for enduring earnings across defence and commercial customer bases. However it recognises that there is a continuing need to maintain "awareness of the depth and breadth within the UK industrial base of those skills necessary to meet and support high-end defence requirements. In those areas there is a risk that unless the skills are exercised regularly, they and/or their currency will diminish". The DIS sets out the strategy for C4ISTAR which includes:

- work with all areas of industry to target defence and commercial research expenditure to activities that offer the greatest potential Defence benefit and which have clear exploitation paths;

121 Ministry of *Defence, Defence Industrial Strategy* Defence White Paper, Cm 6697, December 2005

122 *Ibid*, para B8.1

123 *Ibid*, para B8.43

124 *Ibid*, para B8.47

- continue to encourage wider civil industry to explore the potential application of its knowledge and products to the defence market;

- give industry visibility of our forward plans, and where appropriate the opportunity to help develop potential solutions from an early stage.[125]

115. With regard to UAVs and Uninhabited Combat Air Vehicles (UCAVs) the DIS acknowledges that MoD and industry share a close alignment of interest in UAV and UCAV technology. It states that:

> Although at present we have no funded UCAV programme, targeted investment in UCAV technology demonstrator programmes would help to sustain the very aerospace engineering and design capabilities that we need to provide assurance of our ability to operate and support our future fixed wing aircraft. Such investment would also ensure that we can make better informed decisions on the future mix of manned and uninhabited aircraft which will need to be taken in the 2010–2015 timeframe.[126]

116. The DIS refers to some successful company and MoD-funded UAV technology demonstration programmes. Building on the success of these, the MoD planned to move forward "with a more substantial TDP (Technology Demonstrator Programme) designed to give us and industry a better understanding of key technologies of relevance to UAVs and UCAVs more broadly".[127]

117. **The Defence Industrial Strategy published in December 2005 acknowledged the importance of capabilities and technologies relating to ISTAR and UAVs. In its response to our Report, we expect the MoD to provide us with an update on the progress made to date in taking forward the strategy relating to ISTAR and UAVs. We consider it vital that industry is kept updated on the industrial strategy relating to ISTAR and UAVs to help it retain its position in those technologies where it is currently considered leading edge.**

Defence Technology Strategy

118. The Defence Technology Strategy[128] (DTS) was published in October 2006. Section B3 of the DTS covers C4ISTAR and includes tables setting out priority technologies and national capability requirements relating to the following functions: command and battlespace management; collection; processing; and communications and information systems.[129] The DTS sets out the "way forward for C4ISTAR Technology Development".[130]

119. Section B9 of the DTS covers UAVs. In terms of the UK's position regarding UAS/UAV technology, the DTS states that:

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125 Ministry of *Defence, Defence Industrial Strategy* Defence White Paper, Cm 6697, December 2005, para B8.69-71.

126 *Ibid*, para B4.45

127 *Ibid*, para B4.46

128 Ministry of Defence, *Defence Technology Strategy* for the demands of the 21st century, October 2006

129 *Ibid*, pp 66-73

130 *Ibid*, p 75

> The UK is world class in several aspects of UAS/UAV technology and systems development, including the areas of sensor payloads and synthetic environment based operational concept development. Through procurements such as the Watchkeeper tactical ISTAR UAV programme, and through a structured series of demonstrator programmes, the UK is progressively raising its capability to assess and develop integrated total unmanned system concepts, including autonomous operation for future UAS systems.[131]

120. We asked whether UK industry was still considered "world class" in the areas identified in the DTS. AVM Butler considered that the UK was "certainly world class" in these areas and led in some of them. He added that:

> We do a good array of sensor technologies which are utilised around the world in a number of UAVs. We do well across a number of industry players and there are some capabilities which we have which are pretty unique. For example we have got one very high-altitude UAV which is looking to fly somewhere in the region of 30-odd days once it is fully developed. It is a technology that has been developed in the UK, so again it is something that we are leading in.[132]

121. John Brooks told us that there were certainly areas where Northrop Grumman recognised the technologies in some UK companies as advanced and leading edge. There were cases where Northrop Grumman had entered into discussions "about perhaps capitalising on that capability".[133] Dr Graham Thornton, Managing Director, Northrop Grumman UK, raised the issue of "affordable sovereign capability". In his view:

> Somebody has just got to map out what we really mean by "sovereign capability" and can we afford to be the best, because there is no point in fielding second-best, particularly in a coalition situation. If you have a sensor that is only half as good as somebody else's they will tend to use the other guy's better sensor, it is just commonsense, so maybe we should become a niche player in certain technologies so we really are leading edge and stand up to proper benchmarking against the best. In the area of electro-optics and radars, UK stands out amongst the best.[134]

122. In its memorandum, BAE Systems said that "we staunchly support" the DTS. The company considered that "there is a national imperative for the UK to develop and retain its world-class sovereign autonomous systems engineering skills and system design capability…. The question for the UK is therefore whether it wishes to nurture a national capability to meet its long-term needs or whether to be beholden on generations of off-shore supply".[135]

123. At our evidence session on 13 May 2008 with representatives from UK defence trade associations, we asked how important the technology relating to UAV systems was to UK industry. Dr Moira Smith said that it was a key technology to UK industry at the moment

131 Ministry of Defence, *Defence Technology Strategy* for the demands of the 21st century, October 2006, para B9.42

132 Q 104

133 Q 252

134 *Ibid*

135 Ev 53

and emphasised that the technology was wide ranging and covered "communications, electronics, processing, platforms and novel materials". These were very important to the UK, not just for the military but also for "commercial applications". She told us that Small and Medium-size Enterprises (SMEs) and the large prime contractors were "investing in this technology heavily because they do see this going forward".[136]

124. **The Defence Technology Strategy published in October 2006 set out the "way forward for C4ISTAR Technology Development". In its response to our Report we expect the MoD to provide us with an assessment of the impact which the Defence Technology Strategy has had to date in the C4ISTAR technology area and, in particular, the impact relating to UAS/UAV technology.**

Updated version of the Defence Industrial Strategy

125. In our Report *Ministry of Defence Annual Report and Accounts 2006–07,*[137] published on 28 January 2008, we examined the reasons why the updated version of the DIS had not been published in December 2007 as planned. The new Minister for Defence Equipment and Support, Rt Hon Baroness Taylor of Bolton, wrote to our Chairman on 20 November 2007 and said that:

> I am determined that DIS v2.0 should offer the clarity on our future strategy that Industry is looking for and that it reflects a realistic view of our assumptions and plans. Although the original intention was for DIS v2.0 to be published in December I am convinced that it would be more appropriate for the strategy to be aligned to the ongoing planning round and am therefore in the process of reviewing the publication date to reflect this. Industry has indicated support for this approach.[138]

On 19 June 2008, the Minister for the Armed Forces, announced that "Planning Round 2008 is complete".[139]

126. **The updated version of the Defence Industrial Strategy (DIS) was not published in December 2007 as planned, as the MoD considered that "it would be more appropriate for the strategy to be aligned to the ongoing planning round". The MoD announced on 19 June 2008 that the planning round had been completed. We consider it vital that the MoD ensures that the updated version of the DIS is published without further delay, so that industry is provided with the clarity it requires about future work and where it needs to invest. This is particularly important for those parts of industry working in high technology areas, such as those relating to ISTAR and UAVs. In its response to our Report we call on the MoD to set out the publication timetable for the updated version of the DIS.**

136 Q 111

137 Defence Committee, Fifth Report of Session 2007-08, *Ministry of Defence Annual Report and Accounts 2006-07*, HC 61

138 *Ibid*, Ev 30

139 HC Deb, 19 June 2008, Col 1123

Future requirements

Capability investigation

127. To help identify future UAV requirements, "the MoD Equipment Capability Customer is sponsoring a UAV capability investigation in collaboration with industry which will seek to establish the military requirement for UAVs out to the early 2020s and define how this could best be delivered".[140] AVM Butler provided the following overview of the possible future role of UAVs:

> I can envisage in the far future much of what we do today can be done by UAVs. At the moment we are not quite into that technical bracket but for example we have a study ranging out into the 2035 era which says how much of a mix can we have between manned aircraft platforms and unmanned aircraft platforms in terms of both providing ISTAR but also in terms of providing a strike capability, so an unmanned combat air vehicle as against an unmanned air vehicle for ISTAR purposes, yes, you are absolutely right, and as sensors get smaller and UAVs get more capable then there will be an element of what we do at the moment we can do with an UAV. Out into the 2035/2040 era, I cannot imagine that there will not be a requirement for an element of manned because it gives you some flexibility that an UAV simply cannot give you and also UAVs simply cannot produce the power, the lift, all of the things you need for some of the sensors that we have to carry in a big platform.[141]

128. The aim of the capability investigation was:

> to make sure that industry is able to deliver the sort of capability requirements we need in this area in the future, so it is a two-step process: we are identifying the sorts of things we will need in UAV terms into the future; and then work out how best to deliver them through industry, and of course that will require us to look at industrial sustainability and how we would take that forward.[142]

The capability investigation was expected to "turn out" around the end of September / early October 2008.[143]

129. **We welcome the capability investigation that the MoD is sponsoring to identify the long term military requirements for UAVs and how these might be best delivered. We will wish to be kept informed of the outcome of the investigation once it is completed.**

Maritime UAVs

130. In April 2008, Northrop Grumman won a system development and demonstration (SDD) contract for the US Navy's Broad Area Maritime Surveillance (BAMS) programme. The US Navy chose Northrop Grumman's RQ-4N UAV, a marinised version of the

140 Ev 66

141 Q 70

142 Q 105

143 Q 106

company's RQ-4 Global Hawk.[144] The marinised version of Global Hawk UAV is a land based capability[145] and will provide the US Navy with a persistent maritime intelligence, surveillance and reconnaissance system to protect the fleet and provide a capability "to detect, track, classify, and identify maritime and littoral targets".[146] The issue of UK maritime UAVs was raised in Intellect's memorandum, which states that "Other UAS programmes (such as the Naval ISTAR UAV) have been initiated only to later be cancelled by MoD due to lack of Departmental buy-in, leaving industry to question why time and resource was spent developing a programme without an agreed role in the overall capability."[147]

131. Given that Naval forces are often the first in theatre or are used to gain access to a new theatre, we asked about the MoD's requirement for maritime UAVs. AVM Butler told us that:

> Clearly we keep our requirements constantly under review across all of the three domains including the maritime domain. Given that the UAV is a relatively new concept in naval parlance as well, the one thing we have done is some trials work to make sure you can physically launch and recover a UAV to a deck which, as I am sure you can imagine, is not necessarily as easy as it is launching it from a standard runway and recovering it back to the same. We did some trials work run out of the Air Warfare Centre at Waddington to prove that we can do that launch and recovery concept. We are now keeping maritime UAVs under consideration as we look at the capability required across the breadth of the naval maritime requirement. Again if in filling some of the capability gaps of the future it is decided that a UAV is the best way to fill them, then we will expand on the research work that we have done already to include a UAV programme in the future defence programme.[148]

132. One approach to addressing the issue of launching and recovering a UAV from a ship deck was a rotary wing UAV. Northrop Grumman had an advanced rotary wing UAV [Fire Scout] which had demonstrated the ability to autonomously land and take-off from ships at sea.[149] The US Navy had a requirement for a rotary wing UAV that could land on ships. The requirement was initially for littoral combat ships, but the requirement had expanded to other classes of ships.[150] Dr Graham Thornton considered that there was a need for maritime surveillance on board all classes of vessels:

> particularly in areas such as the Straits of Hormuz in the Gulf of Arabia one needs forward-looking sensing for any group of ships. There is no point in taking ships into dangerous areas if there are small rubber boats with dangerous people and payloads on board.[151]

144 Janes Defence Weekly, *Northrop Grumman wins BAMS maritime surveillance contract*, 30 April 2008

145 Q 231

146 Ev 78

147 Ev 64

148 Q 60

149 Q 232

150 Q 233

151 Q 237

133. The MoD's UAV capability investigation will examine the UAV requirement in the maritime domain. AVM Butler pointed out that:

> many of the UAVs we are using in the land environment, if they are in the right place, can equally be employed in the maritime environment, so again there is some flexibility, particularly with Reaper where you can operate it at some distance from land and still provide the same capability that you would if you had launched it from a carrier for example.[152]

134. **We are both surprised and concerned to learn that the MoD does not have a requirement for a maritime UAV given the ability of UAVs to supplement the limited helicopter availability in warships. In its response to our Report we expect the MoD to set out what consideration it has given to the need for a maritime UAV and the reasons why the naval ISTAR UAV programme was cancelled.**

Autonomous Systems

135. The DTS refers to autonomy in relation to UAVs and states that:

> Autonomous UAS control systems will maximise the effective tactical employment of the unmanned platform. Using on and off board sensors to gain situational awareness of the local battlespace and tactical picture, the autonomous system will then prioritise the vehicle actions taking into account weapon and fuel states, target priorities and deconfliction with other air operations.[153]

136. The memorandum from BAE Systems highlights autonomy in relation to UAVs:

> Our support to current operations has shown how Autonomous Systems can transform military and security operations by providing discriminating capabilities more cost effectively than current Unmanned Air Vehicle (UAV) solutions or other manned solutions to surveillance, tracking and reconnaissance problems. As a result the company continues to invest in the UK to develop leading edge Unmanned Aerial Systems (UAS) that demonstrate increasing levels of autonomous behaviour…. most previous and current generation UAVs only displaced the air vehicle pilot and payload commander to a remote location, the crew remain an intrinsic part of the solution. As a result, UAVs are often just as labour intensive as their manned counterparts and have operating costs to match…. The UAS meanwhile is specifically designed to address these limitations.[154]

137. BAE Systems predicts that "autonomy will be the way of the future for generations to come".[155] Simon Jewell told us that the core technologies that underpinned autonomy in the air were "just as applicable to autonomy on the land and on the maritime surface and sub-surface".[156]

152 Q 63

153 Ministry of Defence, *Defence Technology Strategy for the demands of the 21st century*, October 2006, para B9.46

154 Ev 52

155 Ev 53

156 Q 112

138. Northrop Grumman shared the view that autonomy will be the way of the future.[157] John Brooks said that the Global Hawk UAV, flies itself and "allows the entire crew to focus on the value of what it is you are trying to accomplish. Perhaps that is a good definition of "autonomy". It is not autopilot".[158]

139. AVM Butler told us that "we already have examples where the UAV will get itself airborne, take itself to an operating area, fly a very set route, come back again, and land itself entirety autonomously of an operator". The MoD had programmes examining issues such as "coherent change detection where if you fly over a route once and you then fly over it again, you look at what has changed". One advantage of autonomy was that it took pressure off UAV operators. He considered that, while autonomy was the way to go in some areas, in others:

> it is not what you need, you need that dynamic tasking that you get from having somebody there able to steer it, albeit the vast majority of the way we do UAVs now is a mouse click, it is not actually a physical stick as you would have flying an aeroplane.

He thought that autonomy would be a major contributor in the future, but would not be the answer to everything.[159]

140. **Autonomous UAVs can offer substantial advantages over traditional UAVs and many key industrial players see autonomy as the way of the future. In its response to our Report, we expect the MoD to provide us with details of the programmes it is funding relating to autonomous UAVs**.

Armed UAVs

141. The MoD's memorandum states that planned enhancements to the Reaper UAV "include electronic surveillance and weaponisation of the UAV with multiple Hellfire missiles and GBU 12 precision guided bombs to improve prosecution of time-sensitive targets".[160] On 6 June 2008 the MoD announced that an RAF Reaper UAV had used its weapon system in support of coalition forces in Afghanistan for the first time and that "as with any other munitions this was carried out under strict Rules of Engagement".[161]

142. At our evidence session with MoD officials, AVM Butler referred to the debate that had taken place about the weaponisation of the Reaper UAVs:

> we have been going through a debate for some time about weaponised Reaper because you will be aware in open source that there are plans to weaponise the platform, and again we have been going through some debate there because clearly a release of weapon would be done from Creech Air Force base which is US sovereign territory, so we have to have an agreement with the US that we can do that. There is

157 Q 241

158 Q 242

159 Qq 66-67

160 Ev 66

161 "RAF Reaper fires weapons for first time", Ministry of Defence website, *Defence News*, 6 June 2008

no problem there and that again has been sorted in the very recent past, so no major problems.[162]

143. **Our inquiry has focussed on UAVs and their contribution to ISTAR capability. The MoD has recently used a Reaper UAV to fire weapons during current military operations in Afghanistan. We did not seek to examine the ethics and legal implications of armed UAVs. In its response to our Report, we look to the MoD to set out the broad ethical and legal issues which arise from using military UAVs and how it is seeking to address these. We expect the MoD to develop fully its thinking relating to the future role of armed UAVs and how this impacts upon future manned armed aircraft, such as the Joint Strike Fighter.**

162 Q 48

Conclusions and recommendations

ISTAR and Network Enabled Capability

1. Network Enabled Capability (NEC) is a key future defence capability. In its response to our Report we expect the MoD to provide us with an update on the progress being made to address the challenges to delivering NEC and the latest estimates of when the NEC Maturity States are expected to be achieved. NEC is an area we plan to monitor closely. (Paragraph 11)

The increasing capability and importance of UAVs

2. The capabilities of UAVs have increased significantly in recent years and the pace of change is likely to continue in line with technological advances. The United States in particular has made substantial investment in UAV technology. We note that the MoD has recognised the important contribution that UAVs can make, particularly in relation to ISTAR. (Paragraph 24)

UAVs acquired as UORs

3. The MoD has acquired UAV systems for current operations as Urgent Operational Requirements (UORs). In its response to our Report, we expect the MoD to set out its future plans for the UAV systems acquired as UORs and where the future costs fall within the defence budget. We also expect the MoD to set out its longer term strategy for acquiring UAVs systems, given the concern expressed by industry that keeping the UAV systems acquired as UORs in service for a long time could undermine the UK's national capability in this area (Paragraph 28)

Performance of UAVs on current operations

4. The MoD has acquired UAVs as Urgent Operational Requirements (UORs) for current operations in Iraq and Afghanistan. These UAV systems, such as Hermes 450 and Reaper, are providing "battle winning capabilities" and are proving effective in the counter-insurgency style of operations which our Armed Forces are involved in. (Paragraph 34)

5. The UK's Reaper UAVs, acquired from the US, are operating in Afghanistan. They are delivering vital ISTAR capability at the Theatre/Operational level and the procurement of a US system has provided substantial advantages to the UK. The MoD has assured us that the UK retains operational sovereignty over its Reaper UAVs—it can maintain, upgrade and use them independently. This is an issue we plan to monitor closely. In its response to our Report, we expect the MoD to set out what issues might arise relating to operational sovereignty and the UAV systems procured from the US if the UK/US Defence Trade Cooperation Treaty is not ratified. (Paragraph 38)

6. We commend Thales UK for the speed at which it delivered the Hermes 450 UAV system to our Armed Forces in Iraq and Afghanistan following the award of the

UOR contract. The system is providing vital high quality ISTAR information to our troops on the ground (Paragraph 42)

Lessons learned from current operations

7. We note that, from the experience of current operations, the MoD is broadly content with the assets it has, such as UAVs, which collect ISTAR information. However, the MoD considers that further improvements are required in relation to the Direct, Process and Disseminate elements of the ISTAR chain. (Paragraph 45)

8. Our inquiry has focused on UAVs and their contribution, primarily as collectors of ISTAR information, to current and future ISTAR capability. The MoD has a number of key programmes, such as Defence Information Infrastructure and DABINETT, to improve how the ISTAR collection effort is directed and how the intelligence and information collected is processed and disseminated. In its response to our Report, we expect the MoD to provide us with an update on the progress made to date on these two key programmes. We plan to examine the Direct, Process and Disseminate elements of the ISTAR chain in future inquires into ISTAR. (Paragraph 47)

9. We recognise that when UAVs are operating in hostile environments some losses can be expected. It is essential that the risk of such losses is minimised, particularly in relation to the large UAVs such as Reaper which carry sensitive payloads. In its response to our Report, we expect the MoD to set out the lessons identified from the UAVs lost on current operations, how it plans to address them, and to update us on the number of UAV losses. (Paragraph 51)

10. We note that for some of the UAVs acquired as Urgent Operational Requirements, the MoD is using new approaches to contracting such as "ISTAR by the hour". We welcome new approaches to contracting for defence equipment, particularly where such approaches improve reliability and availability. We look to the MoD to evaluate whether these new approaches are delivering the expected benefits and, if they are, to consider how they might be used more widely. (Paragraph 54)

Watchkeeper programme

11. We note that the Watchkeeper UAV programme is currently forecast to be delivered within the approved cost and to the planned in-service date. We look to the MoD to identify the factors which have resulted in the good progress to date on this programme and how they could be applied on other equipment programmes. (Paragraph 59)

12. We note that, when it enters service, the Watchkeeper UAV system should provide substantial advancements over the Hermes 450 UAV system both in relation to the air vehicle and the ground network enabled infrastructure. (Paragraph 64)

13. The air vehicle for the Watchkeeper UAV system is derived from the Hermes 450 which was developed by an Israeli company. We note that a UK joint venture for Watchkeeper has been created and will hold the intellectual property. Thales UK

assured us that the UK will have sovereign capability relating to the Watchkeeper UAV system (Paragraph 67)

Bandwidth and frequencies

14. UAVs are collecting increasing amounts of ISTAR information, in a range of different formats, which is then disseminated to users. This is putting increasing pressure on the available bandwidth. The MoD is alert to this issue and is "bandwidth conscious". In its response to our Report, we expect the MoD to provide us with a summary of how it is seeking to address the issue of bandwidth and its assessment of the progress being made (Paragraph 73)

Airspace and Air Traffic Control

15. UAV operations in the UK are restricted to segregated airspace as they cannot currently satisfy the requirement to see and avoid other air users. We note that the MoD is working with national and international organisations on this issue. In its response to our Report, we expect the MoD to set out why it supports the ASTRAEA programme only in an "observer role" and its future plans with regard to this programme. We see UAVs, when permitted to operate in the same airspace as manned aircraft, as playing a major role in operations relating to both civil and national defence. (Paragraph 80)

16. We note that the MoD has announced that it is undertaking a public consultation on proposals to extend the existing airspace used by UAVs above Salisbury Plain. We will wish to be kept informed of the outcome of the consultation and to be updated on the progress of the MoD's proposals. If the MoD's proposals are accepted, it will be important that appropriate procedures are put in place to ensure that any disruption caused by new airspace is kept to a minimum consistent with the requirements of defence and security. (Paragraph 85)

UAV operators and imagery analysts

17. The MoD needs the right number of UAV operators with the right skills to make maximum use of the UAV systems it has acquired and is in the process of acquiring. We are concerned to learn that there are substantial deficits in the number of UAV operators in the Army and that the position may worsen when the Watchkeeper UAV system enters service at the end of the decade. We will wish to be updated on the success of the measures being taken to address the deficits in UAV operators. We note that the MoD considers that the deficit in UAV operators has had no impact on current operations. (Paragraph 92)

18. UAVs are delivering increasing amounts of imagery. In order to optimise the value of the imagery collected, the MoD requires sufficient imagery analysts trained in areas such as Full Motion Video. We are concerned that there is an 18% deficit in imagery analysts in the RAF and that a recruitment strategy which is being implemented is not expected to provide additional analysts for some two years. As with UAV operators, we will wish to be updated on the success of the measures being taken to address the deficit in this area. (Paragraph 93)

19. We look to the MoD, in its response to our Report, to provide us with a list of the manning pinch points that impact upon the operation of UAVs, including those trades involved in supporting and maintaining UAVs. The list should set out the current deficits and the action in hand to address them. (Paragraph 94)

Service issues

20. We note that on current operations the RAF is operating the Reaper UAV and the Army is operating the Hermes 450 and Desert Hawk UAVs. The MoD has assured us that this approach has not caused any problems regarding the dissemination of ISTAR information, and that the focus has been on delivering what was required to the troops on the ground. In its response to our Report, we expect the MoD to set out its plans regarding which Service will have lead responsibility for future UAV systems and what consideration it has given to a joint UAV command. (Paragraph 98)

Operating with allies

21. We note that there are arrangements in place to make sure that the UK's UAV systems are interoperable with those of other nations. In Afghanistan, the ISTAR information is collected by Predator A, Reaper and Hermes 450 UAVs, but it can be processed by the same ground terminals. The MoD assured us that, while there were some problems with some systems, these were being addressed. We consider it vital that the MoD ensures that interoperability is a key requirement when acquiring future UAV systems. (Paragraph 104)

Exploiting the ISTAR information collected

22. The MoD faces a major challenge to ensure that the systems which process and disseminate the ISTAR information collected keep pace with the systems which collect it. The MoD's progress in addressing this challenge is a matter we plan to examine in future inquiries into ISTAR. (Paragraph 111)

Industrial issues

23. The Defence Industrial Strategy published in December 2005 acknowledged the importance of capabilities and technologies relating to ISTAR and UAVs. In its response to our Report, we expect the MoD to provide us with an update on the progress made to date in taking forward the strategy relating to ISTAR and UAVs. We consider it vital that industry is kept updated on the industrial strategy relating to ISTAR and UAVs to help it retain its position in those technologies where it is currently considered leading edge. (Paragraph 117)

24. The Defence Technology Strategy published in October 2006 set out the "way forward for C4ISTAR Technology Development". In its response to our Report we expect the MoD to provide us with an assessment of the impact which the Defence Technology Strategy has had to date in the C4ISTAR technology area and, in particular, the impact relating to UAS/UAV technology. (Paragraph 124)

25. The updated version of the Defence Industrial Strategy (DIS) was not published in December 2007 as planned, as the MoD considered that "it would be more appropriate for the strategy to be aligned to the ongoing planning round". The MoD announced on 19 June 2008 that the planning round had been completed. We consider it vital that the MoD ensures that the updated version of the DIS is published without further delay, so that industry is provided with the clarity it requires about future work and where it needs to invest. This is particularly important for those parts of industry working in high technology areas, such as those relating to ISTAR and UAVs. In its response to our Report we call on the MoD to set out the publication timetable for the updated version of the DIS. (Paragraph 126)

Future requirements

26. We welcome the capability investigation that the MoD is sponsoring to identify the long term military requirements for UAVs and how these might be best delivered. We will wish to be kept informed of the outcome of the investigation once it is completed. (Paragraph 129)

27. We are both surprised and concerned to learn that the MoD does not have a requirement for a maritime UAV given the ability of UAVs to supplement the limited helicopter availability in warships. In its response to our Report we expect the MoD to set out what consideration it has given to the need for a maritime UAV and the reasons why the naval ISTAR UAV programme was cancelled. (Paragraph 134)

Autonomous Systems

28. Autonomous UAVs can offer substantial advantages over traditional UAVs and many key industrial players see autonomy as the way of the future. In its response to our Report, we expect the MoD to provide us with details of the programmes it is funding relating to autonomous UAVs (Paragraph 140)

Armed UAVs

29. Our inquiry has focussed on UAVs and their contribution to ISTAR capability. The MoD has recently used a Reaper UAV to fire weapons during current military operations in Afghanistan. We did not seek to examine the ethics and legal implications of armed UAVs. In its response to our Report, we look to the MoD to set out the broad ethical and legal issues which arise from using military UAVs and how it is seeking to address these. We expect the MoD to develop fully its thinking relating to the future role of armed UAVs and how this impacts upon future manned armed aircraft, such as the Joint Strike Fighter. (Paragraph 143)

Annex: List of abbreviations

ACP	Airspace Change Proposal
ASTRAEA	Autonomous Systems Technology Related Airborne Evaluation and Assessment
ATC	Air Traffic Control
AVM	Air Vice-Marshal
BAMS	Broad Area Maritime Surveillance
BDA	Battle Damage Assessment
C4ISTAR	Command, Control, Communications, Intelligence, Surveillance, Target Acquisition and Reconnaissance
CAA	Civil Aviation Authority
CLS	Contractor Logistic Support
DCPD	Direct, Collect, Process, Disseminate
DII	Defence Information Infrastructure
DMA	Defence Manufacturers Association
DIS	Defence Industrial Strategy
DTS	Defence Technology Strategy
EDA	European Defence Agency
EO	Electro-Optic
FMV	Full Motion Video
FRI	Financial Retention Incentive
GCS	Ground Control Station
GMTI	Ground Moving Target Indication
HUMINT	Human Intelligence
IED	Improvised Explosive Device
IPR	Intellectual Property Rights
IR	Infra-Red

ISTAR	Intelligence, Surveillance, Target Acquisition and Reconnaissance
JAPCC	Joint Air Power Competence Centre
JSF	Joint Strike Fighter
NAO	National Audit Office
NATO	North Atlantic Treaty Organisation
NEC	Network Enabled Capability
RA	Royal Artillery
RAF	Royal Air Force
RUSI	Royal United Services Institute
SAR	Synthetic Aperture Radar
SBAC	Society of British Aerospace Companies
SDD	System Development and Demonstration
SMEs	Small and Medium-size Enterprises
TDP	Technology Demonstrator Programme
UA	Unmanned Aircraft
UAS	Unmanned Aerial System / Unmanned Air System
UAV	Unmanned Aerial Vehicle
UAVS	Unmanned Aerial Vehicles Society of Great Britain
UCAS	Unmanned Combat Aircraft System
UCAV	Uninhabited Combat Air Vehicle
UK	United Kingdom
UOR	Urgent Operational Requirement
US	United States

Formal minutes

Tuesday 15 July 2008

Members present:

Mr James Arbuthnot, in the Chair

Mr David Crausby MP	Mr Bernard Jenkin MP
Linda Gilroy MP	Mr Kevan Jones MP
Mr Mike Hancock MP	Robert Key MP
Mr Dai Havard MP	John Smith MP
Mr Adam Holloway MP	Richard Younger-Ross MP

Draft Report (*The contribution of Unmanned Aerial Vehicles to ISTAR capability*), proposed by the Chairman, brought up and read.

Ordered, That the Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 143 read and agreed to.

Annex (List of abbreviations) and Summary agreed to.

Resolved, That the Report be the Thirteenth Report of the Committee to the House.

Ordered, That the Chairman make the Report to the House.

Ordered, That embargoed copies of the Report be made available, in accordance with the provisions of Standing Order No. 134.

Written evidence was ordered to be reported to the House for printing with the Report, together with written evidence reported and ordered to be published on 6 May, 13 May and 4 June.

[Adjourned till Tuesday 15 July at 4.00 pm

Witnesses

List of written evidence

List of Reports from the Committee during the current Parliament

The reference number of the Government's response to each Report is printed in brackets after the HC printing number.

Session 2005–06

First Report	Armed Forces Bill	HC 747 (*HC 1021*)
Second Report	Future Carrier and Joint Combat Aircraft Programmes	HC 554 (*HC 926*)
Third Report	Delivering Front Line Capability to the RAF	HC 557 (*HC 1000*)
Fourth Report	Costs of peace-keeping in Iraq and Afghanistan: Spring Supplementary Estimate 2005–06	HC 980 (*HC 1136*)
Fifth Report	The UK deployment to Afghanistan	HC 558 (*HC 1211*)
Sixth Report	Ministry of Defence Annual Report and Accounts 2004–05	HC 822 (*HC 1293*)
Seventh Report	The Defence Industrial Strategy	HC 824 (*HC 1488*)
Eighth Report	The Future of the UK's Strategic Nuclear Deterrent: the Strategic Context	HC 986 (*HC 1558*)
Ninth Report	Ministry of Defence Main Estimates 2006–07	HC 1366 (*HC 1601*)
Tenth Report	The work of the Met Office	HC 823 (*HC 1602*)
Eleventh Report	Educating Service Children	HC 1054 (*HC 58*)
Twelfth Report	Strategic Export Controls: Annual Report for 2004, Quarterly Reports for 2005, Licensing Policy and Parliamentary Scrutiny	HC 873 (*Cm 6954*)
Thirteenth Report	UK Operations in Iraq	HC 1241 (*HC 1603*)
Fourteenth Report	Armed Forces Bill: proposal for a Service Complaints Commissioner	HC 1711 (*HC 180*)

Session 2006–07

First Report	Defence Procurement 2006	HC 56 (*HC 318*)
Second Report	Ministry of Defence Annual Report and Accounts 2005–06	HC 57 (*HC 376*)
Third Report	Costs of operations in Iraq and Afghanistan: Winter Supplementary Estimate 2006–07	HC 129 (*HC 317*)
Fourth Report	The Future of the UK's Strategic Nuclear Deterrent: the Manufacturing and Skills Base	HC 59 (*HC 304*)
Fifth Report	The work of the Committee in 2005 and 2006	HC 233 (*HC 344*)
Sixth Report	The Defence Industrial Strategy: update	HC 177 (*HC 481*)
Seventh Report	The Army's requirement for armoured vehicles: the FRES programme	HC 159 (*HC 511*)
Eighth Report	The work of the Defence Science and Technology Laboratory and the funding of defence research	HC 84 (*HC 512*)
Ninth Report	The Future of the UK's Strategic Nuclear Deterrent: the White Paper	HC 225–I and –II (*HC 551*)

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Oral evidence

Taken before the Defence Committee

on Tuesday 6 May 2008

Members present:

Mr James Arbuthnot, in the Chair

Mr David Crausby	Mr Bernard Jenkin
Linda Gilroy	Mr Brian Jenkins
Mr Mike Hancock	Robert Key
Mr Dai Havard	Richard Younger-Ross

Witnesses: **Air Vice-Marshal Simon Bollom,** Director General Combat Air, **Air Vice-Marshal Stuart Butler,** Capability Manager Information Superiority and **Air Vice-Marshal Chris Nickols CBE,** Assistant Chief of the Defence Staff Operations, Ministry of Defence, gave evidence.

Q1 Chairman: Welcome to our first evidence session into ISTAR. Just before I ask you to introduce yourselves and to tell us your responsibilities, please, even though you are not all new faces to us, I need to warn you that at five past five there will be either a vote or a series of votes. So, please, do not feel dismayed if we all leave the room. We would be grateful if the fact that we leave will not make you leave. Could you hang on, in patience, for us to come back from the voting? Would you like to begin by introducing yourselves, please, and telling us just the briefest of overviews of your responsibilities?

Air Vice-Marshal Butler: Certainly. If I may start, I am the senior representative here today leading the team. I am one of three military capability managers in the MoD, one from each service, and across the three of us we cover all of the defence acquisition programmes across the board. My specific responsibilities are for C4ISTAR, so all the communications, the ISTAR collection, dissemination, processing, et cetera, and I also look after special projects, which is primarily equipping our special forces, and hence my involvement with unmanned air vehicles.

Air Vice-Marshal Nickols: Air Vice-Marshal Christopher Nickols. I am Assistant Chief of the Defence Staff for Operations. I have two primary roles of relevance to this afternoon: the strategic direction and management of our operations, clearly principally Iraq an Afghanistan but worldwide and UK operations as well, and I also look after the prioritisation and management of in-service capabilities for operations.

Air Vice-Marshal Bollom: Good afternoon. Simon Bollom; I work in the Defence Equipment and Support Organisation. My role there is the Director General of Combat Air, and as such I am responsible for the procurement and in-service support activities associated with all combat air, which includes unmanned air vehicles.

Q2 Chairman: This is an extremely complicated and technologically advanced area, so please bear in mind that we are lay people in this inquiry and explain things to us as though we do not understand it, which, let me tell you, from my point of view, I do not. I will therefore be grateful if you could give us an overview of precisely what ISTAR is and how it contributes to Network Enabled Capability and what is the importance of this to the overall defence of the country?

Air Vice-Marshal Butler: If I may start, probably the easiest way to describe this is as part of the ISTAR chain which is direct, collect, process, disseminate. If I can go through those four stages: direct is really all about trying to prioritise the intelligence and surveillance needs of a commander on the battle field. So, what does he need to know, by when in a particular area? So that is direct, and then turning that into how we task the collectors that will then go out to collect that intelligence surveillance information. Collect is obviously the bit where, whatever type of collector it is goes out to hoover up that information, albeit whether it is an airborne platform or whether it is a ground sensor, or whatever it needs to provide the information that the commander needs, that information then comes in as raw data and then that need to be processed to form an intelligence product, and then the dissemination bit is how that is transmitted to the war fighter, and that war fighter may well be a single troop in the field or it may well be somebody working back here in defence intelligence, for example. So it is whoever needs that information to effectively gain information superiority which gives us the upper hand on any potential enemy. If you regard it as that DCPD chain, that is ISTAR in a nutshell, which, of course, the UAV platform fits into the collect but, of course, we have to consider it end to end, because unless all four bits of that chain work, the commander does not get the information he needs when he needs it. How does it fit into network enabled capability? The fundamental of network capability, to put it in its simplest form, is to take two platforms or systems that would be gaining information and, by virtue of making them work together as a team, produce a better product. So the sum of the parts is better than the individuals working on their own, and that is how the collectors work in an NEC environment, but it is clearly the connection between the two that makes the big difference.

Q3 Chairman: Can you give us an example of how the sum of the parts would be greater than individual items?

Air Vice-Marshal Butler: Of course. You may, for example, have a situation where you have a platform that is providing you with imagery intelligence, maybe live video or something like that, and you have got another platform that is providing you with signals intelligence of some sort, i.e. scanning of radar or listening to people transmit over a radio. Individually one certainly will give you a bearing but may well not give you anything else, whereas the other one might give you some detail, and by combining the two and doing what we generally term data fusion, i.e. putting one over the top of the other, you get a much better idea what the dynamic is that is happening in that particular area and hence better information by joining the two together.

Q4 Chairman: What progress are we making with Network Enabled Capability? Is it good, is it disappointing, is it what we hoped for by this stage and how is ISTAR progressing at the same time?

Air Vice-Marshal Butler: I would say in some areas it is extremely good and in some areas it is more of a challenge, but overall certainly I think we are making good progress. You may well be aware that reasonably recently we appointed a Senior Responsible Owner, the Director Equipment Capability, or DEC[1], who is looking across the whole of the NEC piece to make sure it all comes together, and it is effectively three constituent parts, one being the networks, one being the information (i.e. how we assure the information) and the other one being about people. So it is not just about equipment, it is actually about bringing the three together. We have a fairly comprehensive NEC plan and we are delivering the individual constituent parts of that in individual programmes or system of systems which are coming together to provide network enabled capability, but clearly it relies on a number of things and it is not just about ISTAR. It is actually about how you communicate, how you do command and control, for example, and it is bringing all of those together. I would say overall progress is pretty good. We would clearly always like to move faster but, within the constraints of the financial situation that any organisation finds itself in, it is given its relative priority, and we are constantly assessing, as you know, over time, about where we put our investment.

Q5 Chairman: Network Enabled Capability is an extremely important aspect of defence, but in our inquiry we have to eat this elephant one mouthful at a time, and so we decided to choose within ISTAR UAVs. You say UAVs are particularly important to the collection of the information. Do they have any other function as well?

Air Vice-Marshal Butler: Again, it is important to remember that for a UAV to work it must be a system and must fall within that DCPD chain, because a platform on its own just collecting the data is worthless. What you have to do is make sure that you are able to task it, put it in the right place at the right time, it then hoovers up the information in whatever context it is meant to be doing that, that data is then processed and then we disseminate it. That is where the overlap of the NEC bit and the ISTAR bit come together, but we always have to consider it end to end, and we are at pains to do that on every occasion. So, yes, UAVs are an extremely important part of the collect, but you have got to remember that there is also the actual chain to make sure the information is then given to the right people at the right time.

Q6 Mr Jenkin: UAVs are becoming a major part of the overall equipment programme, competing with limited resources. Is this controversial in defence circles? What do you say to people who say we do not need all this very complicated kit, what we need is more soldiers to put on the ground and then have the Government spend the money on the wrong things?

Air Vice-Marshal Butler: As you know, the MoD is constantly assessing its requirements both in terms of equipment, people, tactics and procedures, et cetera. So my view would be that UAVs, like any other military capability, is balanced in terms of what we can afford to put into the programme over time. We assess the capability gaps that we need to fill and then we look at what is best to fill it. In the case we are working at the moment, UAVs form a key part of filling some of those capabilities that we need to provide. So we are always assessing the utility, for example, of UAVs over other sensors against do we need more people? We are constantly doing that assessment of how best we provide the capability that we need at the front-line.

Q7 Mr Jenkin: What do you say to people who say that all this very high tech, technological internationally shared data is not what you need to fight counter-insurgency wars in Afghanistan and Iraq where you are dealing with people with a Kalashnikov and some home-made explosives?

Air Vice-Marshal Butler: Again, we go through, firstly, a very comprehensive generally annual or bi-ennial capability assessment to work out where the gaps are and then we look at how best to fill those capability gaps, and we always consider it on a capability basis. We do not simply say, "Right, that is a gap; we will fill it with a UAV." We do an assessment to work out what is the best way of doing it. Again, I would argue that it is a balance, and, in fact, certainly in current theatres, there is a thirst for, for example, full motion video, because that is actually what is winning out there, or one of the contributory factors. So it is in constant assessment, and I would argue that we always get the best capability for the capability gap or the situation that is requiring it.

[1] Note by witness: the Senior Responsible Officer for NEC is the Deputy Chief of Defence Staff (Equipment Capability) (DCDS(EC))

Q8 Mr Crausby: Reaper, Hermes 450 and Desert Hawk UAVs have all been procured as urgent operational requirements. Can you tell us why the urgency and their need was not identified earlier?
Air Vice-Marshal Butler: In many cases they were identified earlier actually, and if I can take you through the individual ones, starting maybe with Hermes 450: Hermes 450 was procured effectively as a stop-gap filler because Phoenix, the previous system, was inadequate in a hot and high climate, but, as you know, we have a follow-on to Hermes 450 in terms of the Watchkeeper programme, which was already well established before we did the UOR provision of Hermes 450; so that was there. Equally, if I take the Reaper Programme, we already have in our plans the requirement for a deep and persistent surveillance capability of which Reaper will ultimately be a contender for that longer term programme. However, in the interim, again it was identified and, in fact, in many cases confirmed the fact that we did need a deep system of surveillance capability with a full motion capability and with radar, for example. So arguably Reaper is filling a gap that we had already identified, we do have a programme in the longer term, and it will ultimately, when we get to that stage, be potential equipment that might fill that gap. On the Desert Hawk side, again we have always had mini UAVs for many years[2] and when we looked at the assessment of what we could get on time with the right process and dissemination capabilities, again it filled the gap adequately and we went in to buy it. In the slightly longer term, particularly based on the experience we are getting with Desert Hawk, we will look at how we will fill that capability gap in the future. So I would argue actually the UORs, albeit urgently, because that is why they are UORs, have filled gaps that we had already identified in the longer term programme but we were not quite there. But certainly Hermes 450, for example, will go out of service when Watchkeeper, which is the long-term, already planned programme, comes into service.

Q9 Mr Crausby: How effective have they proven to be on current operations?
Air Vice-Marshal Butler: Chris may wish to mention. The requirement was for something urgently that did both what we call "on tether" UAV operations in terms of Hermes 450 with the Army, and Reaper, which does something slightly more in the deep, i.e. a lot further away from where it is operated, and I would argue that in both cases they have done extremely well and they have been battle winning capabilities beyond a shadow of a doubt.

Q10 Chairman: Chris, do you want to add anything?
Air Vice-Marshal Nickols: No, there is little to add. Obviously, Reaper is only operating in Afghanistan, Hermes 450 in both Iraq and Afghanistan. I think for the style of operations, particularly the counter-insurgency style of operations, the ability to loiter over an area for very long periods, which allows you to watch what we call "pattern of life" so you can build up a picture of what is happening in a particular location is one of the great needs and, of course, that is one of the great strengths of a UAV and that is why they have been so successful. The other point to make perhaps in counter-insurgency, which goes back to an earlier question, is that they very much need to be intelligence-led. You can only find the insurgents through comprehensive intelligence, and that is why the wider ISTAR architecture, including the UAVs, is so important in this style of operations.

Q11 Mr Crausby: What about improvement? I guess this is relatively early days, but we have UAVs, sensors, data links, ground control stations. Which of these aspects could be improved from what we have learned in these current operations?
Air Vice-Marshal Butler: Actually all of them. We can always improve. I think the bit that probably we need to concentrate on more now is the direct process and disseminate, whereas the collector is just about doing what we need it to do. You can always improve sensors, particularly in some of the faster-moving sensors, I would suggest, where you have got things like electronic surveillance, you have to keep pace with the enemy, but generally in collection terms now we are getting reasonably good. It is the direct, process, disseminate chain that we need to put more effort into, and we do, again, have a programme in the longer term to actually start looking at how we might do that much better than we do. In fact, the vast majority of programmes in my area are helping with that DPD as against DCPD chain, but, that said, you can always improve on all of them. It is just that the DPD is probably the bit where we need to make slightly more effort now than we have done hitherto.

Q12 Chairman: So if the direct, process and disseminate is what you need now to concentrate on, precisely what are you doing with programmes within your responsibilities to improve that: because clearly the balance between those four elements is very important?
Air Vice-Marshal Butler: Indeed. If you look across my portfolio, the vast majority are stand-fast areas where we are simply updating collectors to keep them current and operationally viable. The vast majority of what I am doing in my area is based around the DPD effort. For example, we have got one of the biggest IT programmes in Europe currently running with DII, which will enable us to move information across the battlefield[3], and we have a programme in the slightly longer-term called DABINETT, which is effectively joining up the dots. So we have recognised that we have some areas where, particularly in the network enabled environment, you cannot afford what I would call seams, it has to almost work as one single entity, and

[2] Note by witness: Desert Hawk is the first mini-UAV to be deployed operationally with UK forces.

[3] Note by witness: DII will work with communication bearer systems such as Bowman and Skynet 5 to achieve this.

DABINETT is going to help us do that across a whole variety of different phased programmes to effectively join all the dots.

Q13 Chairman: Is that what is described as improving connectivity?
Air Vice-Marshal Butler: Yes, it is, but it is not just improving connectivity, it is also doing things for processing, command and control, et cetera, so it really trying to get at that sort of seamless architecture that you need in an NEC environment.

Q14 Chairman: The Defence Information Infrastructure programme is mainly aimed at what, dissemination?
Air Vice-Marshal Butler: Yes.

Q15 Chairman: So you decide how to direct the UAVs which do the collection, somebody does the processing and the DII shoves it out?
Air Vice-Marshal Butler: Correct, and it is also based around things like being able to do effective command and control and general information to the battle field. So it is a number of things. It is an up to top secret, classified, effectively secure Internet system for both command and control and dissemination of data.

Q16 Chairman: Air Vice-Marshal Butler, did you say you were representing all three services here?
Air Vice-Marshal Butler: I am.
Chairman: Yet you are all three Air Vice-Marshals. We will move on to this. Robert Key.

Q17 Robert Key: I wonder, Chairman, if I could enquire why it is that the RAF is operating the Reapers and the Royal Artillery are responsible for the Hermes 450 and Desert Hawks?
Air Vice-Marshal Butler: The important thing is to concentrate on where the product is delivered, and ultimately the product, irrespective of which UAV it comes from, is delivered predominantly to the fighting troops on the ground, and that is so in all three cases. I think when you look at how the individual UAVs are run and tasked, they are generally tasked by the unit best able to make sure that that information is delivered to the ground. Again, in broad terms, the reason we are operating them at the moment is because the Watchkeeper and the Desert Hawk travel with the Army, and the Watchkeeper, when it is actually flown and tasked, is tasked by the Army, it is on tether, so its line of sight linked to the air vehicle and back again, and it delivers to a fighting unit at the brigade or battle group level; whereas Reaper, because it is generally operating higher, it is much further into the deep, it is much more akin to an air force type strike aircraft and, of course, is much more of a difficult integration problem. So, generally, the Air Force is much better placed because it is more experienced in that type of tasking, but, again, I emphasise the fact that the really important thing is it is done by the people best able to put the product down on the ground where it is required, or, indeed, back into DIS where it is required, or anywhere else. There is not, to my mind, the discrepancy or conflict between the different services because it is where it naturally falls in terms of what we do best.

Q18 Robert Key: Have there been any issues about information being lost between different services or is it a seamless operation?
Air Vice-Marshal Butler: It is as seamless as things are in war time, I would suggest, because these things are never easy, but predominantly there are two main methodologies where information is sustained to the war fighter, and, again, that is either direct from the UAV, wherever it is being flown and by whoever it is being flown, direct to a small ground terminal which the troops have in their hands—either a laptop or on-vehicle borne system—or in the case of Reaper, for example, the information also goes back to the US and is then disseminated on where it is needed. Again, the important thing is where it actually arrives to the ground troops.

Q19 Robert Key: On December 19 last the Defence Security Co-operation Agency in the United States said that Britain had requested the purchase of a billion dollars worth of ten new MQ-9s, which are the Reaper or Predator B.
Air Vice-Marshal Butler: Yes.

Q20 Robert Key: Will the RAF be manning them, operating them?
Air Vice-Marshal Butler: As you may well know, the Predator system actually is to an extent jointly manned anyway, but it is predominantly manned by the Royal Air Force, and I would suggest that if we expand the current Reaper crop, and that is certainly not a given at this stage, again we are constantly reviewing our requirements, the chances are it will be led by the Air Force, because again it fits into the air tasking order and we are best able to integrate it into the wider system, bearing in mind in the battle space it is occupying air space that is also occupied generally by Royal Air Force platforms.

Q21 Robert Key: The Government has told the committee that in January 2008 there was a 48 per cent deficit in unmanned aerial vehicle operators in the Forces. Why is that deficit so big? [4]
Air Vice-Marshal Butler: Can I, firstly, address the deficit because it is certainly not at that level now. It has improved considerably. Again, there was a transition phase for the Army between when they were flying the Phoenix unmanned air vehicle, which as I mentioned earlier was not suitable for hot and high in Afghanistan, so there was a transition period, so we have had to work quite hard to get the right people with the right training to operate the air vehicle, so it is certainly nowhere near that deficit now. The other thing, the important thing in this case is to say that there is no impact at all on the operational theatres. What we are doing on the odd

[4] See Ev 86

occasion is stretching people a little bit much but we do not actually have a deficit for supporting current ops.

Q22 Robert Key: No doubt that is because of the take-up of the £10,000 golden hello that you have offered, but if you have managed to attract people towards the UAV programme, they must therefore have come out of some other part of the Royal Air Force or other technical branches in the Services, leaving deficits with them.
Air Vice-Marshal Butler: Indeed. I can cover the RAF one because in a previous job I did look after it. I am afraid we will maybe have to write to you on the Army side about where they specifically came from.[5] On the Air Force side they have tended to be air crew that have come from other types or operators that have come from other types. It has been a little bit of a learning process for us, I am afraid, because we have not previously operated UAVs in any great numbers, we have started to learn the types of people that we need. So we have taken them from other air crew types and, again, we have done it primarily to meet an urgent operational need in Afghanistan and Iraq, and likewise with the Army. The Army, as you know, with one of their regiments, had a regiment supporting the Phoenix which was the predecessor to Watchkeeper, and again they used the same people.

Q23 Robert Key: Are you seeking to measure this deficit, where they have come from, to fill the UAV requirement, because this must have some impact on the operations of the military in Afghanistan, for example?
Air Vice-Marshal Butler: As you know, for a number of years we have been a shrinking force across all three forces. In the vast majority of cases we have managed to cover the deficit by people that are part of a shrinking force. So, again, it is not an easy equation to make. We have not kept the same numbers, we have actually gone down slightly in terms of the overall service numbers and some people have been reemployed. Again, to an extent we move a deficit around to make sure we can man the forces that are of the most urgent operational need in theatre, and that is what we have done and I am pretty sure that is what the Army will have done as well.

Q24 Robert Key: Chairman, I think this is an important area because I had not realised. We talk glibly about a UAV, but in fact I learn, again from the Defence Security Co-operation Agency, that actually, forgetting unmanned aerial vehicles, you have got ground control stations, multi-spectral targeting systems, Lynx synthetic aperture radar ground moving target indicator systems, satellite earth terminal substations, embedded global positioning systems and initial navigation systems, et cetera. There is a vast amount of test equipment needed and all the rest.

[5] See Ev 87

Air Vice-Marshal Butler: Yes.

Q25 Robert Key: So you are talking about an awfully big number of specialist technological specialists just to man one UAV.
Air Vice-Marshal Butler: Indeed, but do bear in mind that, for example, if you have a UAV delivering imagery, to take an example, we already have imagery analysts that have been doing that work on things like targeting pods, so it is not a new trade *per se*, it is just putting them into a different area where they can utilise their expertise.

Q26 Mr Jenkins: You say that Reaper is run from America and Hermes is run from a particular battle field station. Where does all this information get collected? Is it one central location always doing the processing and analysis at that station? Is the link into it and out of it strong enough?
Air Vice-Marshal Butler: Again, as I indicated earlier, it really depends. It is not quite that simple. There are a number of methodologies where the information is distributed to.
Chairman: I think it would probably be wise for you to hold this answer until we come back. Can I invite members of the committee to vote now and, if there is one vote, to come back as soon as possible, if there are two votes to come back as soon as possible. We are therefore on tenderhooks and in suspense.
Committee suspended from 5.01 p.m. to 5.27 p.m. for a division in the House

Q27 Chairman: We were in the middle of a question from Brian Jenkins, but I wonder if I could ask you to hold fire on answering his question while I ask one slightly frivolous question of my own. Aircraft in the Royal Air Force are flown by officers; in the Army they are flown by non-commissioned officers. Does this difference extend to unmanned aerial vehicles?
Air Vice-Marshal Butler: Yes and no, as always. They are generally flown by the people that are best placed to do it. For example, if you look at Desert Hawk, because of the level they are flown at, they are invariably flown by the ground troops that are controlling; whereas if you take something like a Reaper, because it has much more strategic impact, then, yes, they are generally flown by officers, but they are flown by a mixed team of pilots, sensor operators and technicians and, again, they can be across all ranks and all services, so it does not necessary follow. Watchkeeper, I would have to check, but I am pretty sure they are flown by a mix of the two, again, depending on where they are flown. One of my colleagues tells me NCOs primarily, so senior non-commissioned.

Q28 Chairman: Okay. Do you think that UAVs will form the spear point of changing the differences between the RAF and the Army in this respect?
Air Vice-Marshal Butler: Again, I think the reason we have a slight difference is the strategic impact of the platform that is being employed. Again, I see no reason why that should be any different in

employment of UAVs. Again, it is something that we constantly keep under consideration and we would change as befitting the circumstances.

Q29 Chairman: I thought the original reason was that the RAF flew the strategic deterrent.
Air Vice-Marshal Butler: Again, many of these things are steeped in history and I would not like to go into the details of how we eventually ended up where we are, and there are a number of reasons why we do what we do, but I think the strategic impact of the platforms that we tend to fly generally dictates that we have officer crews, or certainly officer commanders, whereas the Army have taken a slightly different approach to this and they have a mix.
Chairman: Thank you. Now that Brian Jenkins is back, would you like to repeat your question or shall we rely on Air Vice-Marshal Butler to answer it, remembering what you said?

Q30 Mr Jenkins: I think it is pointless repeating the question, Chairman.
Air Vice-Marshal Butler: I did promise I would remember. You asked, effectively, where all of this information comes together. The first thing I would say is it does not always need to come together, because, for example, if you have a UAV on task whose primary role is to provide direct support to a troop on the ground with his small Rover terminal, his small laptop where he is taking the direct information, that is the point of impact, that is where it comes together; whereas if, for example, you are doing something more strategic intelligence-oriented, then the point where it comes together would largely be back in London within the Defence Intelligence Organisation. So, again, it really depends on what the need is for that particular type of intelligence and whether it needs to be fused with other data or the direct picture is actually sufficient for the commander's needs. So it really depends on the need.

Q31 Mr Jenkins: So you feel very confident that a person making the decision at point A, without any link up with the person at point B or point C, is not facing the same type of condition at the present time and, therefore, needs to inform the headquarters that we have got the multiple situations occurring now?
Air Vice-Marshal Butler: If you take something like Watchkeeper, for example, generally the information is being provided concurrently to two sources. For example, it may well be providing direct support to the individual on the ground with his small laptop, but, equally, it is invariably back into at least the ground station, if not into the sort of wider intelligence distribution system, so you have always got two. Again, I think the one thing it may be worth putting our hands up about that we are not quite as good as we would like to be as yet is storage and analysis of that information at a later date; but you can imagine with something like Reaper, on task for something like 15 or 16 hours, there is an awful lot of data that we pull in and, again, it comes back to my earlier point: if we want to improve and we clearly do, then it is that type of thing that we would ultimately like to be able to get a better handle on.

Q32 Mr Jenkins: That is the nub of the question, is it not? How many analysts have you got in station and have we got a deficit in the analysts?
Air Vice-Marshal Butler: Yes, we have. We are short of analysts. Again, it is an area which is one of our pinch points. They are quite difficult to train, it is quite difficult to get the right people and at the moment we do not have as many as we would like, but we are working through processes to ultimately get us up to the level that we need.

Q33 Mr Jenkins: The next question is what percentage are you short?
Air Vice-Marshal Butler: I am afraid, off the top of my head, I do not know. We could certainly find out and provide you with that information, but I do not know in detail at the moment.[6]

Q34 Mr Jenkins: If you could, please, and could you tell us what you are doing to rectify the situation?
Air Vice-Marshal Butler: There is a number of initiatives out there. We are looking at doing a wider search across defence to find out, for example, whether we have got one. We have got current analysts that are employed in jobs which are not analyst oriented. We are looking at how we---. We may in the longer term, for example, look at something like a financial incentive, again, if that is what we are required to do. So, again, within the manpower organisation, we are constantly looking at where the pinch trades are and the sort of actions that we might take to enhance them, just like we are always looking across the equipment arena to try and provide better equipment whenever we can.

Q35 Chairman: If you could write to us with that information it would be helpful.
Air Vice-Marshal Butler: Certainly.

Q36 Mr Jenkin: One of the problems of flying UAVs in combat operations is the friend or foe identification, particularly when operating alongside allies. Could you say something about that?
Air Vice-Marshal Butler: Yes, you are absolutely right. The vast majority of the way we task UAVs on task is via the air tasking order. In many respects, in terms of where they fly, what they do, et cetera, they are tasked as if there are a fixed-wing, manned aircraft, and they are encompassed within an air tasking order, which goes out on a daily basis, which actually lets all of the other air users know where that particular platform is at any one time, and the way the system works, it allows that platform an element of flexibility in terms of where it goes and what it does. Of course, for all intents and purposes, it would be very difficult to know from an air traffic

[6] See Ev 87

control perspective that it is a UAV and not a fixed-wing aeroplane because clearly we communicate through the UAV as if it is an airborne platform. We also have systems already on the UAV to an extent which does an element of identifying where the platform is, so very similar to the ones we use in fixed-wing aircraft, and the final bit of that puzzle is what we call "sense and void", which is an area of technology we are working quite hard on to try and bring forward, but at the moment we do as much as we can to make sure we have got that deconfliction within the air space.

Chairman: We will be coming on to air traffic control issues in several minutes time, but there are other aspects of this that I wonder, Bernard, if you could pursue.

Q37 Mr Jenkin: How do we make sure that we are not just duplicating effort in terms of what other allies are already doing, particularly as we are buying the same programmes and operating in the same areas?

Air Vice-Marshal Butler: I am not sure whether this will get to the nub of your question, but if you consider the Watchkeeper and Desert Hawk issue, they are clearly operating with the Army, so the support we are providing to the Army is wrapped up within the brigade or the battle group that is operating the system; so, clearly, that is providing a unique capability to that particular unit. If you look at Reaper, Reaper is what we call a theatre asset, so it is allocated across the theatre to the ISTAR requirement of most need, so it is planned on a daily basis to make sure we hit the most important theatre asset and it is hence co-ordinated in terms of both priority and air space usage. So, again, there is no real conflict there. In terms of the equipment procurement programmes, when you look at how much we are able to do in theatre, there is always a thirst for more. The decision that we have got to make is just how much do we need to satisfy that thirst and how much do we need to buy equipment to do so? Then again, it is not just UAVs. We collect information, intelligence, in a lot of different manners, UAVs just being one of them. So it is making sure we have got a balance between the need of what we require but then also the balance across the different collectors as to how we provide that particular bit of information to the war fighter.

Q38 Mr Jenkin: Interoperability with allies. One has the impression that we are automatically interoperable with the United States, but what happens with the other allies who have got UAVs?

Air Vice-Marshal Butler: Indeed we are very much on key with the US. If you look at Reaper, for example, it is operated fundamentally over a US tasking system. On the wider issue of interoperability with other nations, we have number of fora where we get together, and I represent the MoD on many of them, where we have UAV focus groups to make sure that, as best we possibly can, we avoid any overlap of things like tasking, for example, and how we do command and control, and many of the other nations work very similar systems either to us or to the US. In actual fact, in theatre at the sort of tactical level there is not a problem because they tend to be supporting their own troops; at the strategic level we do tend to work it across a US/UK predominant battle space. So they tend to link in with us rather than us having to link in with them, but, as I say, there are a number of UAV groups that are together across both bilateral arrangements and "five eyes" and NATO arrangements where we are seeking constantly to make sure we are interoperable with other nations.

Q39 Mr Jenkin: Your answer also raises possible questions of operational sovereignty. Are we over dependent, particularly on the United States, on the question of—

Air Vice-Marshal Butler: Arguably at the moment we are very heavily dependent, because clearly we are using US systems. As you may well know, Reaper, for example, is flown out of Creech Air Force Base in Nevada when it is actually on task, so, yes, we are heavily reliant, but that is not uncommon, and we are across quite a lot of our collectors. The balance there is, in affordability terms, to do it all in-house would be unaffordable. It is quite simple. So, where there is a logical fallback and a sensible fallback and where we need to retain UK sovereignty, we seek to do so, but generally we are fairly comfortable in my arena working closely with the US particularly.

Q40 Chairman: In the United States, do they provide a service, or do they provide a certain number of hours of Reaper, or do we have the equipment which they fly for us?

Air Vice-Marshal Butler: No, we are in a slight transition phase at the moment, but when the full equipment is established for Reaper we will have our own ground stations flown by our own crews, we will use predominantly US satellite links, for example, but that makes it easy because it is a US platform, and the Reapers we will own. So we own all of the constituent bits of the system. If the worst came to the worst, we could probably bring the ground control stations back here and fly it here over UK satellite links, so it is always a compromise, but at the moment, because it is a strategic asset and it is easier to link it into the air space control and the command and control piece, we actually operate it effectively over exactly the same system that the US operate it on, and again there is significant advantage by us being closely coupled with the US in the strategic environment because it makes things like tasking—we get the information from the totality of the Reaper system rather than just our own. So, again, there is significant advantage from doing it that way anyway.

Q41 Mr Crausby: What about maintenance and upgrades? It is operated in the US by our personnel but to what extent will we have an influence on the future processes?

Air Vice-Marshal Butler: Again, almost as much as we like. We are almost entirely free from the US in terms of how we maintain the vehicle, we have got our own maintainers at the moment, but we do get the advantage, for example, of a wider upgrade programme, so, if the US upgrade their Reapers, we get the advantage of being able to buy into that at a relatively low cost. Again, if they are upgrading something like their ground stations, for example, the same deal. Of course there is an element of dependency there, but certainly in terms of the actual maintenance, we are doing all that ourselves for Reaper. There has been a transition phase that we have gone through where we have relied very heavily on the US, but we are slowly coming away from that.

Q42 Mr Hancock: Do you have complete operational control over the deployment of these vehicles?
Air Vice-Marshal Butler: It depends on what context you are talking about there. We have entire freedom as to where we task them.

Q43 Mr Hancock: Do the Americans veto the use of these vehicles?
Air Vice-Marshal Butler: No.

Q44 Mr Hancock: They are wholly owned by us. Do we have to tell them when we are deploying them?
Air Vice-Marshal Butler: No, we do not.

Q45 Mr Hancock: Is it easy to change the task of these vehicles.
Air Vice-Marshal Butler: Relatively. In terms of Watchkeeper and below no problem, but in terms of Reaper, bearing in mind they are a theatre asset, so they are allocated on a theatre basis, we do not actually dictate where they are operated. They are operated against the highest theatre need, and bear in mind the people that decide that are both UK and US. In fact, they are kept generally---. The organisation is run by coalition forces, and in fact both Chris and I have run the air operations centre where that activity is done. I do not know if you have anything to add.
Air Vice-Marshal Nickols: No, I think the benefit we get from putting them into this pool of assets is that, given that our area, particularly in Afghanistan, is one of the busiest areas, we gain more than we lose from that. We get more ISTAR out of the system than we, UK Limited, contribute to the system.

Q46 Mr Hancock: So are there any restrictions on the use of them put on them by the Americans?
Air Vice-Marshal Nickols: Not on the Predator Bs at the moment, no.

Q47 Mr Hancock: On any of our vehicles that we have purchased?
Air Vice-Marshal Butler: The only restrictions that we would have are restrictions that we would place on the system anyway.

Q48 Mr Hancock: Would have. I am asking have we got restrictions placed on any of our systems that we have purchased from the Americans that the Americans have caveated?
Air Vice-Marshal Butler: That is quite a wide question and I could not answer that in open session. I am afraid I could not answer that in open session because there are some areas where I would have to say, no, and I cannot do it here. However, I would say that in general terms restrictions that are imposed on us—and they are very few—would be restrictions that we would impose on ourselves anyway and they are things like overflight of particular countries and things that we would not want to be looking at. They are fairly commonsense things we would be restricted to. The only other thing that I might add is that we have been going through a debate for some time about weaponised Reaper because you will be aware in open source that there are plans to weaponise the platform, and again we have been going through some debate there because clearly a release of weapon would be done from Creech Air Force base which is US sovereign territory, so we have to have an agreement with the US that we can do that. There is no problem there and that again has been sorted in the very recent past, so no major problems.

Q49 Mr Havard: Would it not be right to say, however, that there is an overriding veto on this, should the US deny any one of these assets the GPS system?
Air Vice-Marshal Butler: The denial of the GPS system across the whole of the ISTAR domain would be an issue but again, for example, we get an awful lot of ISTAR information from the US which if they chose to deny it we would be less effective operationally.

Q50 Mr Havard: The question about whether they choose to do it or not is a different issue but technically that is the case, is it not, all of these assets are dependent on the GPS system?
Air Vice-Marshal Butler: Not wholly dependent, no, and in fact in the vast majority of cases we have been running a project in the last couple of years to actually look at what are the dependencies on GPS and what is the fallback option should it be denied. Of course it may not be the US that denies it.

Q51 Mr Havard: Exactly, but you mentioned the different satellite capabilities and so on, so it could still theoretically be used in some way, however, it might have a slightly altered but diminished capability?
Air Vice-Marshal Butler: Indeed. The thing you have to understand is things like what is the accuracy if you are denied GPS.

Q52 Mr Havard: Which is particularly important if you are going to have target acquisition and weaponisation and are going to start shooting people with it.

Air Vice-Marshal Butler: Yes indeed, but on the other hand of course if you are operating a system where you have got laser guidance down to a target, then GPS is actually irrelevant. It is only when you are using a GPS-initiated weapon or it is a matter of getting it on-task.
Mr Havard: I guess we will return to that.

Q53 Mr Hancock: It will still interfere with the target. The laser is only any good when you have got GPS.
Air Vice-Marshal Butler: Absolutely, but bear in mind that GPS is only one of the systems that we use and in fact for example the vast majority of our systems have got inertial navigation systems which do not require GPS.

Q54 Mr Hancock: But they can be jammed.
Air Vice-Marshal Butler: Of course they can[7]. Part of the enemy's philosophy is to deny us use of the things that we require, and again we always work at mitigating these risks.

Q55 Mr Hancock: Are you suggesting that these things are easily overcomeable, because I think they are unstoppable?
Air Vice-Marshal Butler: If I gave that impression, I apologise, I certainly did not mean to do so.
Mr Hancock: I think you did to Dai.
Chairman: Moving on to the Watchkeeper and Robert Key.

Q56 Robert Key: Can you update us on the Watchkeeper programme and the new capabilities that the system will deliver?
Air Vice-Marshal Butler: Watchkeeper brings many of the capabilities that we have currently in Hermes 450 but better because clearly it is a longer term programme, so for example, just to quote one of many, it will have an anti-icing system. Why is that important in Afghanistan? Surprisingly, you do need an anti-icing system in some cases so it is more robust. It will have better rough-field landing characteristics; it will have better sensors because they will be better integrated and they will be a better system, so it is a significant advancement over the current Hermes 450 that we are using on the UOR.

Q57 Robert Key: Is Watchkeeper done and dusted and is that the end of it or are you making changes based on the experience of using it in Afghanistan?
Air Vice-Marshal Butler: Wherever possible, and we do not infringe on the capability that we will eventually acquire, yes, we are taking forward the lessons that we are learning with Hermes 450, as we do, I have to say, across the whole of operational theatres where we have a fairly rigorous lessons identified process and we take that forward into procurement trials, tactics, procedures, et cetera.

[7] Note by witness: inertial navigation systems cannot be jammed.

Q58 Robert Key: Is the in-service date still 2013?
Air Vice-Marshal Butler: No, 2011, and in fact we are fairly hopeful that we will get something in towards the end of 2010, all things being equal.

Q59 Robert Key: Which no doubt depends to some extent on the Civil Aviation Authority?
Air Vice-Marshal Butler: Yes to an extent although that is not one of the major drivers.
Robert Key: Thank you, Chairman.
Chairman: Moving on to maritime UAV programmes and Linda Gilroy.

Q60 Linda Gilroy: Naval forces are often the first to be in theatre, or are used to gain access to a new theatre, so can you tell us a bit about what provision has been made to exploit that sort of situation and to presumably tailor some UAV capability to be flown from the sea?
Air Vice-Marshal Butler: Clearly we keep our requirements constantly under review across all of the three domains including the maritime domain. Given that the UAV is a relatively new concept in naval parlance as well, the one thing we have done is some trials work to make sure you can physically launch and recover a UAV to a deck which, as I am sure you can imagine, is not necessarily as easy as it is launching it from a standard runway and recovering it back to the same. We did some trials work run out of the Air Warfare Centre at Waddington to prove that we can do that launch and recovery concept. We are now keeping maritime UAVs under consideration as we look at the capability required across the breadth of the naval maritime requirement. Again if in filling some of the capability gaps of the future it is decided that a UAV is the best way to fill them, then we will expand on the research work that we have done already to include a UAV programme in the future defence programme.

Q61 Linda Gilroy: That sounds as if it is all at a very early stage.
Air Vice-Marshal Butler: It is.

Q62 Linda Gilroy: But in terms of that capability, while ships and manned air vehicles are reducing in numbers, the general requirement for ISTAR seems to be on the up, it is increasing. Are there in fact known benefits to be gained from operating UAVs as complementary capability to manned platforms?
Air Vice-Marshal Butler: Absolutely no question, and again if we did not have to do some form of balance of investment I am sure we would have many more UAVs than we have in all three domains. However, one comes to the appropriate balance between for example the major fighting units and the equipment that we have on them to gather and disseminate the process ISTAR, so again it is all a matter of looking at this in capability terms, and where we identify that there is a capability requirement, we look at how best to fill it on and

UAVs may well be one of the methodologies in the future, particularly with the decrease in platform numbers as you said.

Q63 Linda Gilroy: Are there any functioning capabilities using that technology at the moment?
Air Vice-Marshal Butler: In the air environment and in the naval sector, no, but we have done the trials work to prove it can be done in its very basic form (although it is clearly very early days) and as we take forward the debate for things like the Type 45 and future surface combatant, if we find that the provision of ISTAR, in terms of the capability work that we do, that a UAV is a good idea, then we will do that. The other thing worth saying is that under the through-life capability management system that we are doing at the moment, we are actually running what we call a capability investigation on UAVs and that will look at the sort of question that you are just posing, and try and work out the question that is being asked in this capability investigation which is what is the UK's future UAV requirement and how might we best provide that in the future? That is certainly sweeping up the requirement in the maritime domain. The good thing is we are ahead of the game because we have looked and proven that we can launch and recover a UAV to a deck on one of the current platforms. The other thing I might mention is to bear in mind that many of the UAVs we are using in the land environment, if they are in the right place, can equally be employed in the maritime environment, so again there is some flexibility, particular with Reaper where you can operate it at some distance from land and still provide the same capability that you would if you had launched it from a carrier for example.

Q64 Linda Gilroy: In the case of the Iran hostages affair, if that capability was far enough developed would it have some utility in that sort of situation to prevent it arising?
Air Vice-Marshal Butler: I might let Chris talk a little more about the actual incident itself, but the answer very simply is, yes, of course it would, but as would a helicopter, as would a fixed-wing surveillance aeroplane of a larger type, so there is a number of things that would always help in that situation, but having done the investigation we demonstrated that, yes, it would have had some utility but not necessarily something that would have changed the final outcome.

Q65 Linda Gilroy: In terms of opportunity cost, is the difference between providing it through that kind of surveillance or through UAV or helicopter and how would that pan out?
Air Vice-Marshal Butler: Again bear in mind that this is always a balance of investment issue because many of our warships already have a helicopter on board so the balance of investment there is quite simply swayed in view of the fact that you have already got a helicopter. For those that do not have a helicopter then maybe UAV does win the balance but, again, I come back to the point that we are constantly reviewing the best way to provide capability across all three domains and where we decide a UAV is the best option then that ultimately would be what we put into the plan. Chris, I do not know whether you want to say anything.
Air Vice-Marshal Nickols: I think the only thing to say perhaps is that there were plenty of systems to give sufficient situational awareness of what was happening around them. The point that Air Vice-Marshal has already made of course is that that particular incident took place very close to land so there was a whole range of systems available and able to operate in that area.

Q66 Linda Gilroy: In evidence we have had from BAE Systems they refer to autonomous systems and their prediction is that that is the way of the future. In that context, which we can all picture, can you outline how such systems compare with UAVs, and is the MoD developing a strategy in that area?
Air Vice-Marshal Butler: I think in the context of the BAE work it is more about you can have a UAV, and we already have examples where the UAV will get itself airborne, take itself to an operating area, fly a very set route, come back again, and land itself entirety autonomously of an operator. There are clearly some areas where that is a real advantage. To give you but one, we have programmes looking at things like coherent change detection where if you fly over a route once and you then fly over it again, you look at what has changed. Again autonomy is really good there because you can be quite accurate on where the flight paths are. You do need an element of being able to dynamically task a UAV just as you would any other system, so, yes, they are right in that autonomy does things like take pressure off the UAV operator because it is quite an intensive operation. These guys are working quite hard for very long hours and they can relieve some of that pressure so, yes, autonomy is definitely the way to go in some areas but in others it is not what you need, you need that dynamic tasking that you get from having somebody there able to steer it, albeit the vast majority of the way we do UAVs now is a mouse click, it is not actually a physical stick as you would have flying an aeroplane.

Q67 Linda Gilroy: So when BAE Systems say to us that it is the way of the future, it is a way of the future?
Air Vice-Marshal Butler: It is certainly a major contributor to the future but it will not be the answer to everything.

Q68 Mr Hancock: In a shared time version you would not necessarily need to recover the vehicle at sea, would you?
Air Vice-Marshal Butler: No, not necessarily and again we had a look at a number of concepts and again it is all a balance of investment. If you have a very cheap UAV flying short distances from the ship, doing a short detection, you might take the capability decision that the fact that you lose it in the sea is not a big deal. If you have something more

sophisticated that flies that bit higher, gives your ISTAR reach more distance, and hence it is probably more expensive, you probably want to recover it to a vessel of some sort or you want to recover it to land, indeed, and we did do both of those in fact, we did actually fly from a ship back to a ship and from a ship to land.

Q69 Mr Hancock: If you think you can get one off a Type-45 presumably you could get one off the deck of a submarine if it was surfaced?
Air Vice-Marshal Butler: Again, it depends how big you want it because you could fly Desert Hawk for example off a submarine very easily. I am not entirely sure we would want to because, bearing in mind we are a complete nuclear submarine force, we probably would want to keep the submarine out of harm's way and pretty quiet. Part of the operational philosophy is that you do not let people know where it is so I can think of very few instances where you would want to do that, but you could easily fly a Desert Hawk. To fly anything bigger would be tricky.

Q70 Mr Jenkin: You referred to balance in an earlier answer to one of my questions. Does the dramatically increasing capability of UAVs actually bring into question what the maritime aviation requirement will be, not just in terms of numbers of manned aircraft that we might put on the carriers but does it raise the question of whether traditional carriers as we have envisaged them now more than ten years ago in the Strategic Defence Review are still relevant?
Air Vice-Marshal Butler: Part of the answer to that question is it is not just the maritime environment of course it is wider than that because I can envisage in the far future much of what we do today can be done by UAVs. At the moment we are not quite into that technical bracket but for example we have a study ranging out into the 2035 era which says how much of a mix can we have between manned aircraft platforms and unmanned aircraft platforms in terms of both providing ISTAR but also in terms of providing a strike capability, so an unmanned combat air vehicle as against an unmanned air vehicle for ISTAR purposes, yes, you are absolutely right, and as sensors get smaller and UAVs get more capable then there will be an element of what we do at the moment we can do with an UAV. Out into the 2035/2040 era, I cannot imagine that there will not be a requirement for an element of manned because it gives you some flexibility that an UAV simply cannot give you and also UAVs simply cannot produce the power, the lift, all of the things you need for some of the sensors that we have to carry in a big platform

Q71 Chairman: Why does a man, or for that matter a woman, in a vehicle give it more power or lift?
Air Vice-Marshal Butler: It does not, it is just that to lift a bigger sensor, a more powerful sensor, you need a bigger platform. If your question is can we in 2035 or 2040 fly a larger platform unmanned, potentially, yes, but again it depends where you want to do the processing of the ISTAR data. It is all a matter of balance again because you may find one of the reasons in our larger manned platforms we put people in it is simply because it means we can analyse the data on board and hence get it to the war fighter much quicker, depending on the type of data, because if it is signals intelligence for example you have to do quite a bit of analysis before that signals intelligence is useful, and you can do it almost immediately if you are doing the analysis at the point of collection rather than having to ship it back, analyse it and push it out again. Again, it is all a matter of balance.

Q72 Mr Hancock: Surely you would have two different types of vehicle, would you not, you would have the one that did the intelligence job and the one that did the killing job and they would not necessarily be anywhere near each other, would they?
Air Vice-Marshal Butler: No, absolutely not.

Q73 Mr Hancock: So you would not put a high-risk surveillance vehicle with a lot of expensive sensors on it in harm's way if you can avoid it—
Air Vice-Marshal Butler: Correct.

Q74 Mr Hancock: But once you know where harm's way is, the vehicle you send there could be totally different, could it not, because that is the vehicle that would replace many of the jobs that your combat aircraft have to undertake now with human beings on board, and you take a few humans out of a plane you save 300 lbs in weight immediately.
Air Vice-Marshal Butler: The way we tend to utilise the UAV, because of where we are with technology largely, is to do the dull, dirty, dangerous and deep but, again, as UAVs become more advanced, then we are doing more and more with a UAV that we currently do with a manned platform. For example, we are currently using UAVs, or have done in both Iraq and Afghanistan, where previously we would have had to have used a manned platform and, again, it is largely limited by the technology—power and lift. When I talk about power I am talking about things like cooling power, electrical power, et cetera, to operate the array of sensors that you might need.
Chairman: Moving on to things like bandwidth and frequencies, Richard Young-Ross?

Q75 Richard Younger-Ross: The NATO Joint Air Power Competence Centre has some concern regarding both bandwidth and frequencies. It feels that there was not enough bandwidth to support unmanned aerial systems and there were no dedicated frequencies for such systems, or indeed no international standard frequencies for such systems. Could you outline those issues and tell us just how critical they are to the working of unmanned aerial vehicles?
Air Vice-Marshal Butler: There are two issues largely with the UAV, one is the command and control route, ie how you tell the UAV to move

around and how you tell it where to move and the other is the dissemination of the data. The first one is very simple: you have to almost have a 24/7 link while the thing is airborne because you need to be able to command it. Albeit, as BAE Systems have pointed out, the autonomy to an extent can get around that and there are procedures in place where for example if a UAV loses its link it does not simply dive into the ground, it carries on on its last order or it recovers back into a holding area where we can pick it up on a shorter range link and land it. I have to say it is not a major user of the bandwidth doing the command and control. The bigger issue is the issue of disseminating the data, and the data can be very hungry in terms of bandwidth particularly if you are trying to do real-time full-motion video, for example. Again, wherever we can as we develop the capability, we are looking both nationally and internationally at how we can minimise that issue, and that can be done via a whole variety of means. For example, in the Watchkeeper era we were not necessarily getting into full-motion video all the time, it will be frame at a time at set intervals. Equally, we are looking at what is the best way to disseminate the information. If you transmit a picture over the Internet, for example, you can transmit it in a number of different formats. What we are looking at is what is the format that uses the absolute minimum bandwidth transmission to get it over the system. Again, we are looking at a lot of techniques as to how to do that. The other thing is we engage in the World Radio Conference to make sure that the military bandwidth that we require is allocated to us, and then we use it in the most effective manner, because of course we have to pay for bandwidth now, as you may well be aware. A number of things are coming together which minimise the bandwidth problem. This is very much a personal view having worked in this arena for the past three or four years. We will get to the point where if we keep using bandwidth we will saturate the commander with information. Of course it comes to the point where you have to make a compromise on the fact that you cannot give him too much so you need to give him just enough to give him that information superiority that he needs as a commander, but no more. There is a bit of a balance there and again it is a bit difficult. One of my colleagues has passed me some useful information to bring up on a previous point. One of the other reasons of course why some of the bigger platforms that we utilise are used in the manner they are is because they can store and analyse the data on board and they do not need to push all of the information they collect down to the ground, so again it is another way of saving bandwidth. We are very bandwidth conscious, I would suggest, in terms of cost, in terms of making sure that when the commander requires the information we are able to push it to him, but also in terms of the fact we need to command and control and we need to provide the right data at the right time and the right place.

Q76 Richard Younger-Ross: What about dedicated frequencies?

Air Vice-Marshal Butler: Again we go to a great deal of effort to make sure the frequencies we use are allocated to us but of course if you take Iraq for example we do not control the frequency usage in Iraq. We can bid for it just like we can in any other place, but the sovereignty of the bandwidth relies on the host nation country. I will be the first to say it has caused us problems in the past, and one of the things we have learned is when you put a system into a theatre you really need to have dialable bandwidth, so if the one you are attempting to use is not a good one you can move the dial a little bit and transmit on another one. Dynamic bandwidth management is something we are becoming increasing adept at.

Q77 Robert Key: I spent a fascinating day at the National Air Traffic Control Centre and I realised just how complex the management of airspace is over Europe, more specifically over Great Britain and the oceans. Am I right that any unmanned aerial vehicle cannot comply with either visual flight rules or instrument flight rules?
Air Vice-Marshal Butler: Up to this point we have not operated UAVs in segregated airspace. We always have to operate it within a Danger Area simply because, as you rightly say, there are a number of facets of manned flight that we currently cannot achieve with a UAV, and one of them is 'sense and avoid'; we cannot teach a UAV what to do.

Q78 Robert Key: That is why the European Defence Agency in January announced a €500,000 contract with a consortium, including defence and aerospace interests, to try and find the way through this. Is the Ministry of Defence part of that programme?
Air Vice-Marshal Butler: We are engaged on a number of different programmes, not least of which is ASTRAEA, where we are attempting to come up with solutions to exactly that type of problem, both nationally and internationally I might add.

Q79 Robert Key: So until we make progress with that, you can only fly UAVs in this country in a danger area?
Air Vice-Marshal Butler: That is correct.

Q80 Robert Key: Or in a restricted area (temporary) under Article 96 of the Air Navigation Order 2005, but what is the difference between a restricted area (temporary) and a temporary segregated airspace, TSA?
Air Vice-Marshal Butler: For all intents and purposes of flying a UAV, nothing.

Q81 Robert Key: But technically what is the difference, please?
Air Vice-Marshal Butler: Simon, is that something you have got?

Air Vice-Marshal Bollom: I do not have that.
Air Vice-Marshal Butler: I am not sure we have it to hand. We can get back to you, but for the purposes of flying the UAV, to us, the area restrictions are the same. We have to observe the same sort of safety regulatory regime.

Q82 Robert Key: I would be very grateful if you could send us a note saying what is the difference because in their evidence to us the CAA refers to these zones as restricted area (temporary) but others, including QinetiQ, talk about temporary segregated airspace.
Air Vice-Marshal Butler: Again we will write to you but I am pretty sure they are talking about exactly the same thing. [8]

Q83 Robert Key: The real problem with all this is that a single-engined beast like UAV could drop out of the sky and with luck it will glide, but it may not be lucky. There have been a number of problems with these, in Israel of course and elsewhere, so how do you assess the risk of UAVs failing and falling out of the sky?
Air Vice-Marshal Butler: Of course the air worthiness regime that we go through for UAVs is the same airworthiness regime that we go through with an ordinary fixed-wing aircraft. The sorts of failure rates on a UAV that is designed to the same standards as, let us say for example a single-engined light aircraft, are very, very similar, so again the element of risk there is one associated with a Cessna 150 or any light aircraft which again is single-engined.

Q84 Robert Key: And at the moment the only place where UAVs are being trialled is down at Aberporth I think?
Air Vice-Marshal Butler: Indeed that is where we are tending to do the majority of the trials although we have done trials elsewhere. In fact, the earlier maritime investigation that I referred to was done up in the north of Scotland.

Q85 Robert Key: But given that the Royal Artillery is going to be training the Army in how to use these things tactically, the Salisbury Plain Training Area is the favoured place, and I have to convince my constituents that there is not going to be a problem with UAVs buzzing around, which of course they cannot see and they cannot hear but they know will be there. I gather that at the moment the Civil Aviation Authority has not come to a satisfactory agreement with the Ministry of Defence. How long do you think that will be because we know that Thales has told us their contract is absolutely bang up-to-date and that is fine but if they are not allowed to fly these things, is this going to mean slippage for our Forces?
Air Vice-Marshal Butler: There are a number of things we are doing and we also have fallback options in both cases. We would like to operate it in Salisbury Plain because in terms of routine training that is clearly the best place for us to do it, that is where the Army units are operating. However, we have to go through the same CAA regulatory regime that we would for any other aircraft. I referred to Danger Areas but what we mean is an area of restricted airspace where we can fly the UAV. However, we do have fallback options and, in the extreme, for example, there are a number of danger areas in the US that we could use. Clearly that means that we will not get quite the standard of training, certainly on the routine side, that we would do back at Salisbury Plain but we do have fallback options should we be required to do so. Salisbury Plain is pretty critical because we do need to, as best we can, fly it on a routine basis when the Army are operating in Salisbury Plain, and that is where they do their routine training. So we have a fallback which will not be as good but again I emphasise that we have to go through the same regulatory regime with the CAA that we would with any other request for a change in area and we are doing so at the moment.

Q86 Robert Key: I understand that and I am very grateful on behalf of my constituents who will be much reassured and that is all very well, but we are using UAVs currently in Afghanistan and Iraq so actually we are saying it does not matter if they drop out of the sky on top of Afghan people and Iraqis?
Air Vice-Marshal Butler: No, that is not true either. We have gone through an airworthiness regime to fly any air vehicle in any country, and we have to get clearance to do so, and we go through a fairly strict regulatory regime. It is all weighed off against the risk and also the circumstances in which you are flying them. Again the risk rates for flying your average UAV are broadly similar to a single-engined light aeroplane so they are not that dissimilar.
Air Vice-Marshal Bollom: Just to reinforce the point, for military aviation we tend to operate in terms of probability of injury somewhere in the order of 10^{-5} and in putting together the safety case for Reaper, and indeed for Watchkeeper, we are operating in exactly the same regime and you take account, as my colleague has mentioned, of a whole range of factors. It is not just how you design the air vehicle and how it is produced and maintained; it is how it is operated and the sorts of areas that it is going to fly, so that is all done very rigorously in the same way that we would with a manned vehicle.

Q87 Robert Key: Are you between you, three distinguished Air Vice-Marshals, part of the assessment of the use of autonomous vehicles in general in the military sphere?
Air Vice-Marshal Butler: Can I just say that the safety case for a particular platform is led and owned by the Service that operates them, but what we do have to have is an independent safety adviser who will look at the safety case that we put forward and provide advice back to us.

[8] See Ev 87

Q88 Robert Key: Of course it is not just the military, Chairman, who will be using these vehicles, we already know that a number of police forces are trialling them, and this does lead to whole new areas of risk that have to be assessed within the civilian community, let alone the military because there will be civilian applications, and people are thinking about this, I hope?
Air Vice-Marshal Butler: Yes, as I say, we have a very strict regulatory regime for flying UAVs, exactly the same as we would if for example we procured a new single-engined light aircraft. We would have to go through the same regime there and the standards are very similar.

Q89 Robert Key: If a UAV does fall out of the sky, who will be responsible for any injury or death caused by that system?
Air Vice-Marshal Butler: I would have to come back to you on that one.[9]

Q90 Robert Key: I wish you would, please.
Air Vice-Marshal Butler: Because again it is not simple. It depends on where it is and who it is being operated by.

Q91 Robert Key: It is why I asked the question.
Air Vice-Marshal Butler: Yes of course and again we can come back to you on that one.

Q92 Mr Havard: You could use them in the area of Salisbury Plain now as long as they are within that area. The argument, as I understand it, is having to come out of that current area in order to use all the stand-off capability for the machinery; is that right?
Air Vice-Marshal Butler: That is correct.

Q93 Mr Havard: But we have training areas in BATUS in Canada and Hungary and so on; I presume there is no difficulty in using them with joint training there, is there?
Air Vice-Marshal Butler: No, it is simply a function of size. Because the capability you have with Watchkeeper requires a much greater standoff distance for you to get the full impact of the sensor, Salisbury Plain Training Area is simply not big enough. It was for Phoenix but it is not for Watchkeeper. BATUS, as you know, is a much much bigger training area so hence there is not an issue out there and of course it is a permanent Danger Area.

Q94 Mr Havard: It is just you mentioned the United States of America but you did not mention these others.
Air Vice-Marshal Butler: There are a number of these around the world. There are quite a lot in the Middle East as well for example so there are a number of areas where we could use them should we be required to do so.

[9] See Ev 87

Q95 Chairman: Getting back to the allies question, the NATO Joint Air Power Competence Centre has said that the integration of unmanned aerial systems is not occurring in NATO and, "Nations are developing stove-piped systems that do not integrate with each other nor with NATO networks." Do you agree with that?
Air Vice-Marshal Butler: To an extent yes but largely no. We go through a number of systems, as I was mentioning earlier, on the bilateral side but also on the international side initially at "5-eyes", we do some at "7-eyes", some at NATO and some of the coalitions of the willing and it really depends on how we are looking at it as to how we integrate UAV systems. For example, the data that we provide from Reaper goes into a central collection centre in Al Udeid in Qatar as it happens and that information is used by almost every nation within the coalition. It is quite frequently transmitted on individual nations' transmission systems or on a NATO system, for example, but it is available to the vast majority of the coalition so in that sort of case it is very simple. It is transmitted where it can be, but there are a number of issues. I will be perfectly honest, when you have a UAV transmitting data down to the ground on a direct line, for example, you need the correct receiver at the bottom, so what we need to do as part of the planning process is make sure the UAV that we are flying in a particular area suits the particular troops that we are supporting, which again is more of a planning issue of the "direct" bit of the DPCD cycle, so in general terms it is pretty good but I am not under-estimating the challenge there. Unfortunately, in terms of the balance of investment, you have to hang your hat somewhere and there are a number of NATO standards which we always conform to. There are a number of interfaces which we recognise we have to make work and again we do that at a variety of different international fora to try and make sure we get the best from what we have got available.

Q96 Chairman: I think the answer you gave about the dissemination of the data across different countries was aimed at the second 'D' part of the DPCD whereas what this report was referring to was the 'C' part, the collection, and there are lots of different types of UAVs none of which seem to be compatible with each other.
Air Vice-Marshal Butler: Indeed, but again I will refer you to one of the things we mentioned to one of the earlier questions and that is the fact that the focus of all of this needs to be where the information is being delivered. To a soldier on the ground with his laptop who is receiving his picture, he does not actually care whether it is Reaper or whether it is a Watchkeeper or whether it is a Canadian system or an Iraqi system; he just wants his data, so providing the standards work, it does not really matter.
Air Vice-Marshal Nickols: It is just worth making the point for instance in Afghanistan an awful lot of the UAVs are either Predator As, Reapers or Hermes 450 and the same ground terminal will accept the imagery from all three of those, whether

they be UK, US, or indeed any other nation, so while there are still some problems with some systems we are tackling it and addressing the problem, particularly in the operational areas.

Q97 Mr Crausby: Some questions about future ISTAR capability requirements. What ISTAR capability is the MoD seeking in five years' time and could you say something about weaponisation as well with regard to the UAVs over that period and what issues will arise from all of that?
Air Vice-Marshal Butler: We are constantly keeping the ISTAR capability requirements under review. There are a number of systems which we currently have in the plan on which we could certainly send a note to you but I would not want to discuss it in open session. Regarding the arming of UAVs, I think there is a declared open intent that we will arm Reaper. We do have clearance to do so from the US and it will be carrying the Hellfire missile largely and a small bomb. Outwith that there are no current plans, but we are constantly keeping our requirements under review and that does not mean to say that it will not be so in the future.

Q98 Mr Crausby: Can you say something about the speed of technology change as well. Are we not in danger of technology changing so quickly that by the time these things are ready they are over?
Air Vice-Marshal Butler: Not really. The change in technology of the platform itself is not that rapid. It has been and if you were to draw a graph of how the technology has gone, it has gone very steep but now it is starting to level out because we have got to a point where you can largely build it faster or bigger or smaller, so it is not a giant leap in the technology itself. The only additional bit I would add to that maybe is the advent of the unmanned combat air vehicle where we do already have some research, as you will be aware, under the Taranis programme with a consortium led by BAE Systems looking at the unmanned combat air vehicles, so there are some advances to be had there because it deals with different requirements to the UAV but largely we are there with standard UAV platforms.

Q99 Mr Crausby: What about specialist personnel, how is the MoD ensuring that we have the right levels? Is this an area of concern?
Air Vice-Marshal Butler: It is. We are learning very rapidly by operating the systems that we have. The Army for example are very familiar with operating with a tactical UAV because they have done it with things like Phoenix for some time so it is no giant leap for them. For the Airforce it has been because we have been getting into an entirely different way of doing business. We have learned the lesson very quickly over the last year or so and we now have a better understanding of the type of person that we need and we are making sure that we have got a future plan to generate that type of person.

Q100 Mr Jenkins: It is not the technological change of the platform that concerns me, it is the change in the sensors, the collection, the compression, the processing and transmission of the data. If we make a quantum leap in the next two years (and given the amount of money the Americans are throwing at it we might well do) this may well make our systems, if not redundant, second class insofar as they are not able to absorb the information and decode the information fast enough. Have you got a fallback position for this?
Air Vice-Marshal Butler: My view would be that that will not apply because for example if you take Predator B it is an adaptable platform, to give you an instance, and we are just about to put a different sensor into the Predator B. The payload bay is not fully adaptable but it is pretty adaptable so you can actually take out what we have got at the moment and put a new one in. That leads again to regulations that we need to go through to make sure it is still airworthy and a whole bunch of things but it is adaptable enough generally to be able to take different sensor systems. Should that technological leap come forward we can take one out and put another one in and, again, the issue there is making sure that you have got things like the right power supplies and the right capability to lift it; it is a weight issue. Generally they are pretty flexible, particularly the larger UAVs, and of course the smaller ones are providing very simple EO/IR generally, which is the big output from them, so it is not a major issue. The sensor just gets better and better and better in terms of clarity but it is not a major change.

Q101 Mr Jenkins: Is there any risk at all that the encoding and transmission of American systems will be so advanced that our systems will not be able to pick up their signal and decode it in the near future?
Air Vice-Marshal Butler: No, at the right-hand end of arc we could actually go through our own transmission system should we wish to do so, so we can negate it in that manner, but actually we stay in step with the US all along this piece, and things like encryption for example are things where make sure we stay on board and stay on the same lines. There is a risk from things like jamming, which again we mitigate by technology and making sure we have got the right cryptographic feeds in to make sure we can transmit the systems over both their lines and our own lines so it is not a huge risk.

Q102 Mr Havard: This is going to come at you a bit left field and I apologise because you might not be able to answer it. There is a debate about Nimrod and about the numbers of Nimrod, their longevity, and whether or not there are going to be the original numbers that were talked about and so on. Given the speed of these developments in terms of the UAV technology and all the rest of it, there has to be relationship between these two things. How is that being factored in? Is it the case that in your five years ahead that we are going to see less of the bigger platforms and more of the smaller platforms?

Air Vice-Marshal Butler: By pure coincidence I happen to be a Nimrod pilot so I can answer this with a fair amount of surety. The Nimrod MRA4 that we are bringing in service is predominantly an anti-submarine warfare platform. It will be a significant amount of time before that particular task can be undertaken by a UAV. That is not to say it cannot be in the much longer term but certainly in terms of the length of the Nimrods' in-service time it will be not be possible to do it by UAV. The other thing worth saying is because it is quite often confused, the Nimrod MR2 used in the manner in which we have been using it in Afghanistan has been misemploying an ASW aeroplane because we have not had something that is as good as what it is doing in theatre. And it has done a fantastic job, as I am sure you will acknowledge. As UAVs get better, we are able to do much of that task with a UAV and clearly it does in many cases fall into the dull, dirty and dangerous regime and so we would do it with a UAV, but not in the ASW game. You need a large aircraft with the sensor array that it does have to complete the task and I believe that it will be a long time before we will be able to do that with a UAV.

Q103 Mr Havard: However that segmentation is becoming clearer?
Air Vice-Marshal Butler: Yes to an extent, but there is an element of the Nimrod MRA4 task that you can do with UAV and it is all a matter of having this 'golf bag' approach, but the fundamentals of an anti-submarine warfare role would be difficult with a UAV. Of course because you then have the platform there will clearly be other ISTAR capability areas where you will utilise the platform simply because you have got it and hence it makes it good value for money to do so.

Q104 Chairman: Industrial issues—and this is the final batch of questions—the Defence Technology Strategy of a couple of years ago said that the UK is world class in several aspects of UAS/UAV technology and systems development, including the areas of sensor payloads and synthetic environment based operational concept development. Are we still world class in those areas?
Air Vice-Marshal Butler: Yes we are certainly world class and we lead in some of them indeed, so, yes, I think we are. We do a good array of sensor technologies which are utilised around the world in a number of UAVs. We do well across a number of industry players and there are some capabilities which we have which are pretty unique. For example we have got one very high-altitude UAV which is looking to fly somewhere in the region of 30-odd days once it is fully developed. It is a technology that has been developed in the UK, so again it is something that we are leading in.

Q105 Chairman: All of this relies on the necessary skills being in industry. How is the Ministry of Defence working with the defence industry in the UK to ensure that those skills are preserved in industry?
Air Vice-Marshal Butler: As I mentioned earlier, one of the things we are doing at the moment is a capability investigation into UAVs to make sure that industry is able to deliver the sort of capability requirements we need in this area in the future, so it is a two-step process: we are identifying the sorts of things we will need in UAV terms into the future; and then work out how best to deliver them through industry, and of course that will require us to look at industrial sustainability and how we would take that forward.

Q106 Chairman: What is the timescale of that study?
Air Vice-Marshal Butler: The investigation should turn out around about the end of September/early October and we are consulting widely with industry in taking that forward.
Chairman: Gentlemen, thank you very much indeed for a very interesting opening session. I think you have cleared away many of the clouds that were fogging my mind, at any rate, and I am most grateful; it was very helpful. The session is closed.

Tuesday 13 May 2008

Members present:

Mr James Arbuthnot, in the Chair

Mr David S Borrow	Mr Bernard Jenkin
Mr David Crausby	Mr Brian Jenkins
Mr Mike Hancock	Mr Kevan Jones
Mr Dai Havard	Robert Key

Witnesses: **Mr Simon Jewell,** SBAC and BAE Systems, **Mr David Barnes,** UAVS and Thales UK, **Mr Clive Richardson,** Intellect and QinetiQ and **Dr Moira Smith,** representing defence SMEs and Waterfall Solutions Ltd, gave evidence.

Q107 Chairman: Good morning. I am very sorry to have kept you waiting at the beginning of this meeting but we had a lot of things to discuss about other issues. Could we begin by asking you to introduce yourselves and give the briefest of potted histories of what you do and why you are here to give evidence.

Dr Smith: I am Moira Smith and I am pleased to be here. I am representing the small and medium size enterprise firms involved in UAV technology. Obviously the Defence Manufacturers Association encompasses the whole spectrum of the defence companies in the UK but I have been particularly asked to come and give you the perspective of the SME community, and I am happy to do that today. My particular background, to keep it brief, is although I have worked for primes in the past in 1999 I set up a small defence company to bring innovation and technology as quickly and effectively as possible to service the defence community. I believe that is why I have been asked to speak for the SMEs.

Mr Barnes: I am David Barnes and I am current chairman of the UAVS, the Unmanned Aerial Vehicles Society of Great Britain. I am also the current chairman of the SBAC's Autonomous Systems Strategy Group and employed by Thales as a business development director working from Weybridge.

Mr Jewell: I am Simon Jewell. I worked for BAE Systems but today I am representing the Society of British Aerospace Companies. I am the chairman of the Systems Engineering for Autonomous Systems Defence Technology Centre, which is an MoD activity, and I am also chairman of ASTRAEA which is a consortium of government, local government and industry which seeks to open the UK air space for autonomous systems.

Mr Richardson: I am Clive Richardson and I am the chief operating officer of QinetiQ. Today I am representing Intellect, the hi-tech trade association. Intellect has a considerable interest in the whole area of UAVs and UAV systems generally and its members probably account for something like 10 per cent of UK GDP across a wide range of subjects. It is increasingly interested in taking technologies from the commercial sector into the defence environment. I have also worked for twenty years for BAE Systems where I held a number of posts. I latterly ran a business called Insyte which was the defence systems business within BAE principally engaged in the non-platform end of ISTAR and UAVs in areas of data analysis and data dissemination.

Q108 Chairman: In the written evidence we have had there have been references to Unmanned Aerial Vehicles, Unmanned Air Systems and Autonomous Systems. I wonder if somebody could give a brief overview of the differences, and the extent to which these overlap and precisely what is meant by each of these expressions.

Mr Barnes: There is a lot of confusion about the terminology used with Unmanned Aerial Vehicles; they have been called Uninhabited Air Vehicles. The general usage these days is to refer, in the UK anyway, to unmanned air vehicles as such. Unmanned air systems are the complete system involving the UAV as the platform but also reflecting back to the supporting situation: the environment, the communications links and the other bits and pieces.

Mr Jewell: The movement that we are seeing over the years from UAVs to UASs reflects two changes: one is that the systems historically were piloted remotely whereas what we are moving towards are systems which are capable of operation autonomously, or with degrees of autonomy, and hence the movement towards the autonomous system. The system component is the recognition that it is not simply the vehicle. The vehicle is simply the platform of carrying the capability and, therefore, both of those are evolutions as we move forward.

Mr Barnes: UAV is generally taken to mean just the platform.

Mr Richardson: The system aspect I would describe as looking at four key things: you are looking at tasking the platform, the platform itself, the process of analysing the information that the platform collects, and then the process of disseminating that information and passing that information on. Those four elements would comprise the UAS, the system, rather than Unmanned Aerial Vehicle.

Q109 Chairman: That was described to us last week as DCPD.

Mr Richardson: That is Ministry of Defence lexicon.

Mr Barnes: To clarify, DCPD generally refers to the ISTAR activity.

Q110 Chairman: It applies to the UAVs as well.
Mr Barnes: Yes, in that usage with ISTAR.

Q111 Chairman: Could you give us a sense of how important the technology behind all of this is at the moment to the defence industry, and to the British defence industry, and how you see that developing in the future?
Dr Smith: It is a key technology to the UK industry at the moment but there are couple of key points worth making. First of all, UAV or UAS technology is wide ranging and covers everything, as was said previously, from communications, electronics, processing, platforms and novel materials. There are a huge range of technologies there, many of which are seen as key components and very important within the UK not just for the military community but for commercial applications as well. There is a wealth of excellent technology that can be pulled through. In terms of the benefit of the UAV and the UAS, that is seen as key as well because most of the companies, certainly SMEs and the larger primes, are investing in this technology heavily because they do see this going forward. The technology is here to stay and it will be built upon.
Mr Barnes: It is important to note also that whilst the basic technologies exist and are being developed and are improving, there is still a distance to go in terms of designing, installing and approving such systems as the collision avoidance systems.

Q112 Chairman: We are getting on to air traffic control later on.
Mr Barnes: That is where it is crucial. The other end of the scale is we also need developments in communication technologies to cover the links. We will refer to those later as spectrum problems.
Mr Jewell: I agree with Moira's statement but just to add to that, we have to recognise that the core technologies that underpin autonomy in the air are just as applicable to autonomy on the land and on the maritime surface and sub-surface. The ability that we can generate through these systems in the UK is applicable to all of those. Of course it is just as applicable in the defence, para-military, policing market as it is in the civil market as well. Whilst people may have a difference of opinion as to when the technology will mature, when the systems will be capable of wider application, I think most people would agree that over time that it is an inevitable direction path and, therefore, where we are at is a cusp of a disruptive technology that could be very important to the UK and that is why I think it represents such a key opportunity.
Chairman: I was talking to John Howe of Thales this morning and he reminded me that UAVs are very much being flown at the moment and are very useful in our current inventory.

Q113 Mr Crausby: Reaper, Hermes 450 and Desert Hawk have been procured as urgent operational requirements. To what extent is UK industry involved in these programmes and can you tell us in what way?
Mr Barnes: The UK industry is involved to a degree. All of those programmes, as I am sure you recognise, were bought overseas. They represent developed capabilities and they were required for urgent deployment in active theatres. The UK industrial activity in those programmes is comparatively small and is not technological and is largely operational assistance with operations.

Q114 Mr Crausby: What about lessons learned? To what extent are any lessons in the use of these programmes being fed back into UK industry?
Mr Barnes: In my view that is happening but not directly. The lessons learned are being fed back in terms of changes to the operational requirements now being put to UK industry by the Ministry of Defence.
Mr Richardson: There is an involvement in those programmes in certain specialist areas. Getting the equipment into service in the UK environment is certainly something that QinetiQ gets heavily involved in. Increasingly, as the other elements of the UAS system become embedded in the UK ISTAR architecture, there will be increasing involvement from UK industry around the analysis and the dissemination of information.

Q115 Mr Crausby: Could there be more involvement for UK industry? Is it a satisfactory situation that there is not much involvement?
Mr Richardson: Ideally we would have had our own platforms and our own programme but that has not been funded over the years. Consequently, if there is an urgent operational requirement and there is a system available then it is in our overall interests that the capability itself is deployed. We can learn from the use of that capability and then in the future we will be able to play a much bigger role.
Mr Jewell: It is a sensitive area because we all recognise the compelling case for an urgent operational requirement, however that itself should not become the strategy to provide the capability in the longer term and that is the delicate balance that needs to be played: the support for current operations which everybody would support and praise but also the risk that that investment is coming from investment that would otherwise be placed in raising national competence. Certainly SBAC would like the see the balance being maintained between developing national capability and supporting UOR capability for urgent operational requirements.
Mr Barnes: Simon said it well and I cannot add to that except to say there is a danger, and the danger is in pursuing UORs and keeping them in service for a long time we will undermine our national capability to develop and deploy.
Dr Smith: From the SME community there is a real need to see a pull through of technology, of which there is plenty, and if there is a platform there we have to have the knowledge that there is an exploitation path.

Q116 Mr Crausby: Hermes 450 and the Desert Hawk are being provided as a managed service: ISTAR by the hour. To what extent do you think that is a pattern that may become an increasing habit of the MoD and is there some concern about that?
Mr Barnes: I do not think there is too much concern about it from industry in that it is a proven and perfectly respectable procurement mechanism which can be applied to any vehicle in any situation. We see it as workable and not necessarily to the disadvantage of UK industry. It would remain a matter for the MoD as to whether or not it is more efficient.

Q117 Robert Key: I was quite surprised that the Ministry of Defence told us they have enough UAVs or, to quote, "in general terms, there is sufficient dedicated collection capabilities in service or due to enter service". Do you agree that they have the right number of UAVs providing ISTAR collection capability?
Mr Richardson: I do at the moment, yes, but that is my view. They are collecting vast amounts of data and I would advocate that, within the overall system, we give enough funding and credence to the other elements other than the collector so that we know that we can use the information that is being collected sensibly, that we see genuine operational benefits from the use of that information and we prove those benefits before we then move to the next phase which is very much demand driven: we want more collectors now. If the MoD is saying they have enough, then they have enough.
Mr Jewell: Industry would always want to say that it wants to sell more systems. The real point is the systems that the MoD currently operate do precisely what Clive has described, which is place a massive burden on the exploitation of the information chain. The autonomous systems that collectively we are talking about and developing between the UK companies are of a type which will reduce that burden. The amount of information and intelligence which is being applied to the capture of the information, and then of the analysis of the information, itself will become more and more autonomous. Whilst, therefore, I would not necessarily argue with the MoD's point that they have the right number, I would argue they have the wrong type and, therefore, the introduction of smarter systems will actually help to reduce the burden of the information exploitation goal.

Q118 Robert Key: Is that about the quality of the information collected by the UAV?
Mr Jewell: When you are looking at the sensor systems on board, clearly you can either be doing that with a broad swathe, a wide area, or a narrow focus. Today what the military want is precise information and trying to get the balance right in today's systems is quite difficult. The next generation of systems will be more capable of being able to apply its own control and rationale as to which sensor is using when and therefore applying more applicable data back to the military intelligence community.
Mr Barnes: It is important to recognise here that the MoD has a force mix at the moment which encompasses fixed wing operations, such as Nimrod, ASTOR, Helix and the E3 Eagle. Some of that capability in the not too distant future will disappear. The MoD, therefore, has requirements for an increased tactical capability through Watchkeeper and, as far as we can understand, an increased strategic capability through Reaper-type vehicles. I think the force mix will change over the years. The MoD will know better than I what it needs in service at the moment but in the longer term that force mix will change and, in my view, it will probably embrace more Unmanned Air Vehicles.
Dr Smith: It is understandable that with the early systems we needed a capability, we needed vehicles to be up their flying around and the focus was not necessarily perhaps on the processing that they provide but to be able to gather the information. We are now at the stage where the focus can shift. There is a point made about the platforms having certain capability and there is an emphasis now, very much coming through from the MoD funding, to look much more at the data deluge problem and, as Simon says, the use of autonomy to improve how we handle the data and make the most of it. There is an awful lot of technology already available which could be put through quite quickly to help that process.

Q119 Robert Key: I understand this is about a lot more than just an Unmanned Aerial Vehicle and is about all the ground support, technical engineering support, analysis support, communication support. It is a very big package. What aspects of that package could be improved to increase the effectiveness of UAVs in providing the ISTAR capability?
Mr Richardson: You are always going to have a trade-off between the sophistication of the platform and what is done in the ground environment because of attrition. If you put too much into the platform itself, and you can have ever more sophisticated platforms, at some point you hit this problem that if you are losing them you are losing very valuable assets. That is a cost capability trade-off that would have to be done. In terms of what could you put on the platform itself, you could put more advanced sensor suites. You could put analysis capability on the platform itself so it is sifting the information in the air before it sends it to the ground so you reduce the bandwidth problems which reduces the data analysis capability on the ground, and so on and so forth. Advanced levels of cryptography, we need to do more work there, so sophisticated sensors and more work in crypto. We need to do more work in the secured passing of information and the assured passing of information. There are a number of areas that we can continue to invest in.

Q120 Robert Key: Given the potential for UAV systems, do we actually need the Nimrod system and programme?
Mr Barnes: Which Nimrod system?

Q121 Robert Key: The £800 million eight years over budget.
Mr Barnes: The Nimrod MRA4. There are two Nimrod systems at the moment: one is an ISTAR collection facility, 51 Squadron; the other is the current work being undertaken by maritime Nimrods in Afghanistan.

Q122 Robert Key: I am referring to the first. Has the technology just overtaken it?
Mr Richardson: You are asking a question in connection with the overall ISTAR architecture and the role of Nimrod within the overall ISTAR architecture. I am absolutely convinced that the architecture, as it is drawn up today, requires Nimrod. If you want to re-architect the whole ISTAR environment to do away with Nimrod, perhaps you could do that but it is a huge task that would take many, many years.

Q123 Chairman: We have a risk here of going down a rabbit hole.
Mr Barnes: Could I go back to the original question of where it could be improved. Improvements are possible across the board and Clive has touched on most of them. For me the most important area for improvement is in information management, in the sorting, distribution and earmarking analysis of information collected by whatever platform. There is a wealth of work to be done there, which the MoD is conscious of, and those things are starting to happen.
Mr Jewell: Areas of importance for me are very much around the deployed logistics footprint of an unmanned vehicle today. They are called unmanned yet they are very heavily manned on the ground and, therefore, the next generation needs to be considerably leaner in the way they operate and deployed which will fundamentally change the cost benefits of operating the system.

Q124 Linda Gilroy: I was interested in what Clive Richardson said about attrition and the relevance of that. Could you say a bit more about that? I am also interested in what David Barnes said just at that moment about the platforms as opposed to the processing arrangements for it. If the processing is so important, why are the platforms things which we should consider it necessary to develop our own capability on?
Mr Richardson: On the attrition side, in the tactical environment closer to the conflict zone it is clearly going to be a problem for all UAVs. They are not particularly stealthy. If they were stealthy then you are putting more money into the development of the airframe itself.

Q125 Linda Gilroy: Can you give the Committee some idea of what the rates of attrition are in practice?
Mr Richardson: Even if I had the information I would not be able to give it to you.

Q126 Linda Gilroy: That is a relevant issue.
Mr Richardson: It is a relevant issue but it is less relevant the more strategic the asset. The further away from the conflict zone, so very high altitude, long endurance UAVs, and the UK has invested quite considerable sums in HALE systems, they are less vulnerable but also less capable of carrying the sort of payloads that a tactical UAV is capable of carrying. There is that constant trade-off. In any analysis of the development of new UAV capability that trade-off would be of considerable importance, that calculation.
Mr Jewell: The air-worthiness component for a systems design is based around equivalents. It needs to have the equivalent air-worthiness safety as a manned platform so that is the presumption and, as Clive has described, if you then place that in a war zone clearly you end up with combat losses. The basic assumption from industry is it is building platforms which have the equivalence of safety as a manned platform.

Q127 Linda Gilroy: We took some evidence about this last week and understand that the MoD does not currently have any maritime UAV programmes. Are we likely to see the MoD having a requirement for them in the future and are any UK companies involved in developing them?
Mr Barnes: Trials have been done with maritime orientated UAVs, both in the UK and in the States, and it looks as if the Americans will go for a UAV capability as part of their maritime detection upgrade. In my view, yes, we will but that task can be covered by long endurance high level UAVs such as those currently being used by the US, based on land in many situations. The MoD would have to make that balance between ship-borne UAV capability and land-based UAV capability.

Q128 Linda Gilroy: Are the MoD likely to have a requirement for armed UAVs in the future? If so, is UK industry likely to be involved or to procure from the US?
Mr Barnes: The MoD currently has a requirement for Reaper to be armed. Reaper is armed as a basic part of its capability. Armed UAVs, I believe, are being considered by the MoD but you would have to ask them what their plans and intentions are. There is, of course, always the loitering munition programme which is currently being launched by the MoD.

Q129 Linda Gilroy: Could you tell us a bit more about the last mentioned capability?
Mr Barnes: The loitering munition is basically a weapons system. It is basically a guided weapon but it has a long endurance and would use a UAV-like airframe. It is, in fact, a flying munition with a longer endurance than current flying munitions such as Storm Shadow.
Mr Richardson: I think it is part of IFPA: indirect fire precision attack.

Q130 Chairman: It is a merger between weapons and intelligence collection.

Mr Richardson: It does not have the intelligence characteristics, so not really. It could not carry the payload to collect enough information to be useful really.
Mr Jewell: The indirect fire precision attack programme looks at the requirements for modern long-range artillery effect. That is the overall MoD programme. It is in the assessment phase. The loitering munition capability is a sub-component of that overall look. As has accurately been described, there are various options for a vehicle based solution. People do use the language of UAV based but, in a sense, that creates an impression that is slightly misleading. It is a munition capable of sustained flight for a longer period. It is a unitary warhead.

Q131 Mr Hancock: I am curious about this issue about the loitering munition. Presumably there is also a defensive capability of the UAV that will bring down another UAV, and is that being worked on?
Mr Jewell: To my knowledge there is no current counter-air capable UAV. I am not aware of any in development. Conceptually, yes, there is absolutely no reason why, in the future, that should not happen but I am not aware of any developments, certainly in the UK, taking place on that.

Q132 Mr Hancock: If you can have a loitering munition vehicle you could have a loitering attack vehicle that is there to take them out, could you not?
Mr Jewell: Yes.

Q133 Mr Hancock: I was interested in the paper that Intellect provided, particularly the very interesting chapter on challenges and the issue about the collecting of huge amounts of information and how much of it is actually useful and are the systems on disseminating the information received keeping pace with the ability of these things to bring back information, 80 per cent of which was already known in Operation TELIC for example. Are you confident that these UAVs are not supplying so much information that the system becomes so clogged up with information that is already known that you actually lose the advantage of them because it takes so long to get what you really want, which is new information?
Mr Richardson: There is a problem in that the more information that is collected then the more information has to be analysed or wasted and that is just a fact. There are various sources of information now to increase situational awareness. Ensuring you are actually using the information intelligently is the next big challenge in my opinion. Robert Key asked if we have enough collectors in the air and I think we do. A huge amount of effort has to go into now ensuring that the information that is collected is managed effectively, gets to the right place, can be shown to have got to the right place and is used intelligently.

Q134 Mr Hancock: Has that phenomenon been known right from the beginning that these things would bring back so much information?
Mr Richardson: I think it has. In any reconnaissance technology you are necessarily increasing potential for collection to an extent that the existing operational processes would struggle to keep up.

Q135 Mr Hancock: You make a suggestion that the financing of one thing has not kept pace with the financing of the other. We are still spending lots of money on UAVs and their capabilities but we are not spending the money on making sure that the information is handled probably.
Mr Richardson: The point I am making is that is a natural cycle. Collecting the information is always going to be the priority because that will enhance situational awareness which is the main objective of this entire capability area. What is now required is the acceptance that we have got to a point that there is enough data there now for no more to be needed until we have the spend focused on analysing that data effectively before we move on to the next collection cycle.

Q136 Mr Hancock: Is there evidence to support that view, that that is now becoming a priority within the MoD?
Mr Richardson: I think there is. Certainly in my interactions with the ISTAR capability area there is now an acknowledgement that the next phase needs to be on the efficient use of the information rather than moving on to ever greater collection capability. Certainly if you look at future programmes like DABINETT, which is still a key funded element in the ISTAR budget, that is entirely about using the assets more effectively, using the information more effectively and investing in the analysis, data mining and the data dissemination.

Q137 Mr Hancock: What is British industry doing to help that situation?
Mr Richardson: Certainly we are all very heavily involved in all aspects of the UAS loop. Some of us, certainly the SBAC members and BAE, would have a strong interest in the future platform capability as well. We are all heavily involved in the other technology areas that would support unmanned aerial systems.
Mr Jewell: We need to be careful that we do not over-simplify it and that all the investment should be on the DCPD process or the vehicle. To take an example, if you go back a few years the information was collected on wet film. You would have someone on the aircraft, you would take the film, you would land the aircraft, you would take out the film, process it and send it to an attendance bay. Between 24 and 48 hours later you then had the information you had captured. What is possible today with the developments of autonomous systems is that process can be collapsed down to 15 seconds. From actually taking the information to having the information in the hands of the intelligence community has come down to that extent and, therefore, it is not simply to say it is all about the exploitation, which is a massively important component, and it is certainly not all about the vehicle, but it is that system component from the capture of the information in

the right place to the exploitation of the information at the right place, and that needs a balance of investment rather than a switch from one to the other.

Dr Smith: This is a key point: the shift towards processing technology and the need for turning data into actionable knowledge. That is really what it is all about. The MoD, from the perspective of the small companies and the DMA, is such that that is noted. There has been a dramatic shift in the last few years towards research and development and investment, not in the larger programmes like DABINETT but bringing through technologies to help in this area to improve data mining, to cut down the amount of information that is either data linked and sent back, or else to sift through the vast amounts of data. In terms of what the UK industry is doing about it, because this technology is relatively new you are seeing a lot more companies, and small companies, coming into the field that maybe traditionally have not been supplying to the MoD. The benefits are coming through there as well. Simon can probably speak a little more on the Systems Engineering for Autonomous Systems Defence Technology Centre. They are funding and putting a lot of emphasis in this area, even to be able to exploit imagery and listen to images is one of the examples I would site. There is genuinely a paradigm shift that is occurring.

Mr Barnes: It is important also to recognise a simplistic consideration here. It is true that the UAV in its routine patrol duplicates a lot of information already held but the important point is because of its persistence it misses less so there is the potential for much greater coverage. This is crucially important in force protection where IEDs and other devices can be laid in moments unobserved. Information missed is as important as information collected.

Mr Jewell: If I can follow up on that point on the Defence Technology Centre, the Defence Technology Centre is co-funded by industry and the MoD 50/50 and, therefore, the point Moira made at the beginning about seeing the exploitation routes for that investment is extremely important to the people who are involved in that. The work breaks into six sectors: algorithms, mission planning and decision making, sensor exploitation, communications and control, propulsion power and energy management, and systems engineering of the overall component. A lot of the work and focus is going on now. Rather than simply ask a camera to switch on and 10 seconds later ask it to switch off and you then you present that 10 second swathe of information back to an analyst, what we are working on is being able to analyse every single frame of the information and through techniques such as object recognition or anomaly detection to have the intelligence in the system itself such that it recognises that either something is different from yesterday or something is there which should not be there because it is a man-made object in an otherwise non-man-made environment. The systems are having the capability to react to that information and to then reprogram itself in order to get different shots and different angles of that information and send it back. That is the approach I was trying to suggest is the way we reduce the burden on the system of having another 24 hours of streaming video which somebody has to sit and go through. This is early work, it is maturing, but the maturation rates of this technology are extremely fast. A question which was asked earlier about the ownership process of whether it should be commercially operated, I would suggest that given these very fast maturation rates the MoD needs to be continually upgrading the systems. It is not buy one and operate it for six years; it will be changing on a monthly basis and, therefore, that needs to be taken into account in not only the sovereignty issues of upgrading platforms but also in ownership questions as well.

Q138 Mr Hancock: Is there a willingness in the MoD to take on board that principle that this is a continuing changing pattern and that it is ridiculous to buy something believing it has a long shelf life because it is just moving so fast?

Mr Jewell: It is fair to say that through the National Defence Industries Council there are several joint working groups between MoD and industry looking at the revisions to acquisition change which need to take place in contracting and acquisition reform. It is being addressed, and clearly everybody would like to see a faster pace, but nevertheless it is being jointly looked at.

Q139 Mr Jenkins: It is a tremendous area to work in, it is cutting edge, leading the world, and there are tremendous spin-offs. Do you have any indication how much is being spent in this process of collecting, analysing and utilising this information in a non-MoD area? How much of the work is being done by British industry but funded not by the Ministry of Defence as a percentage of the total fund? Do you have any idea?

Mr Richardson: I am speculating but I would say it is insignificant.

Q140 Mr Jenkins: Industry has no confidence at all that this is worthy and they can sell it?

Mr Richardson: It raises a particular issue and that is the use of UAV assets in controlled air space. At the moment there is no effective way of putting a UAV into controlled air space because there is no collision avoidance system on a UAV; there is no human in the loop so to speak. At the moment that is a huge issue for any commercial organisation in deciding whether to invest in this area. To change that regulatory environment is probably a 10 to 15 year task and that holds back investment in that area.

Mr Jewell: You framed your question looking very much at the exploitation of the information. Certainly industry is investing in the Defence Technology Centre I mentioned and that is a six year commitment. It is spending £60 million over that time of which industry is investing £30 million over the period. There is also the ASTRAEA programme, which is the programme that I have the pleasure of chairing, which is looking to open the

UK air space. It has currently committed £32.4 million of which industry is spending £16.2 million over a three year period. That money runs out at the end of this year and we are looking to launch the second conclusive phase of the programme. We are looking to raise a further £44 million of which industry will submit half, £22 million, over the next three years. That is not under contract but something we are moving towards. ASTRAEA does not have any MoD money at all. That money was raised from a combination of 13 different funding sources. Whilst it is informative to the lengths we have to go to raise the money, there are seven companies investing in that: BAE Systems, Thales, QinetiQ, EADS, Rolls Royce, Flight Refuelling and Agent Orientated Software, a small SME; and we also have the Welsh Assembly Government, the Scottish Executive, the North West Regional Development Agency, the South East Regional Development Agency and the South West Regional Development Agency. All 13 came together around this core programme raising £32.4 million. That is the public money that is being spent. If you then add the private venture R&T money that is being spent over the years, then that runs into the hundreds of million of pounds. Very significant investment has taken place in this capability which is why it is so essential that we see evidence of the ability to pull through that capability across the UK to systems.

Mr Barnes: I agree fully with what my colleagues have said. There are, of course, early stages in the government's examination of the prospect for using UAVs on a commercial basis. DEFRA have recently initiated a programme which will look at an evaluation of a maritime patrol capability for fisheries protection on a commercial basis. The current estimate for first flight trials, notwithstanding Clive's identified problems with air space, is March 2009.

Dr Smith: There is probably a lot of investment again from the private sector that is not necessarily easy to quantity and is probably not being monitored by any particular body. I am certainly aware of a vast range of small companies in the UK investing in aspects of the technology that are geared towards UAS, whether it is for the commercial sector or something like the Grand Challenge with the Ministry of Defence focus.

Mr Jewell: To give you an example, in the academic area Oxford University, Heriot-Watt, Bristol, Imperial, Bath, Wolverhampton, Loughborough and York, and that is not an exclusive list, all of those universities are contributing to the Systems Engineering for Autonomous Systems Defence Technology Centre. It has very wide breath and most of those will be bringing background intellectual property that is being pre-invested.

Q141 Chairman: Are we doing the wrong inquiry here? The reason I ask that is if what you have been saying is correct we are collecting an awful lot of information by these UAVs, and the main problem is not the UAV collecting it but what we are going to do with it; are we going to get the right information and analyse it properly. This inquiry is into the UAV focus of ISTAR. Should we really be looking at the analysis targeting and dissemination of the information rather than the collection of it which, from what you were saying Clive Richardson, is essentially done and dusted and everything is struggling to keep up? Is that correct? Struggling to keep up is the phrase you used.

Mr Richardson: I would suggest that you should not look at this in terms of a snapshot in time. Your inquiries are a proper inquiry into UAV capability both now, medium term and in the longer term. However, in considering the collection of data and the subsequent use of that data I think that you do have to look at the collection capability through phases. If we now have sufficient collector capability then we can cycle through the next phase into the efficient use of that information through into investment in future platforms. The use to which we put the information today will inform the development process for future platform capability, or it ought to. It is an integrated system, however I think your inquiry into the platforms and the collector capability is appropriate given the fact that without that you have no data to analyse in the first place.

Mr Jewell: Whilst a lot of the emphasis has been on the collection side, we have to recognise that today we cannot operate an autonomous air vehicle in the United Kingdom. We can operate it under extremely restrictive conditions in either existing danger areas or air space that has been segregated for its special use and operation. Therefore, for the MoD to train, or indeed for any commercial exploitation or police operations or any other requirement that may require usage in the UK, we cannot do that today.

Chairman: That is a very important question and it will be the way we end this morning's session but not yet.

Q142 Mr Jones: You are very good salesmen. Is it not that you are actually doing what all good salesmen do and sell the MoD something which is the latest technology, it can do X, Y and Z, but at the end of the day it comes down to the human factor? You are going to get a situation where you are going to overload the individual with so much information that he or she is going to be blinded by it. Is it not better looking at more practical approaches to what front line troops need? I will give you one example. There is a good, kind officer of 42 Commando Company, Buster Howes, who led the invasion of Al Faw peninsula. There is a very good presentation which I think everyone should look at if you are looking at Network Enabled Capability. Having landed in mud up to their waists on the El Faw peninsula most of the stuff did not work. The two things that were more vital to him were two stolen Czechoslovakian motor bikes which allowed him to send two spotters and a sniper forward to look at some date palm that apparently had been photographed God knows how many times but nobody knew what was in it. Is it that we should not become over-reliant on this and be cautious when you are telling MoD that everything can be done by this new technology?

Mr Jewell: Your point about reliance on technology is very valid. I am a former infanteer myself and the one thing, when I was in the services operating in Germany for four years, that we needed most but did not have was information. We used to sit deployed forward against the notional threat that existed at that time and we would have no means of actually knowing who was friend or foe, where our own forces were relative to ourselves or where the enemy forces were relative to ourselves. We effectively operated blind. The approach that I was trained in when there was a sniper somewhere in the advance, if you do not see the sniper, was that you instructed one of your men to run forward to draw fire and to then engage that enemy. I would suggest that the capabilities that are on offer today are what I would have wanted at least 30 years ago when I was in the services. I do not believe it is technology for technology's sake.

Q143 Mr Jones: Can you not become over-reliant on it? If you have a situation whereby you are doing all the training to the point that all this is available to you and then suddenly you go blind because you are up to your waist in mud and things do not work.
Mr Jewell: I agree with your point.

Q144 Mr Jones: Are we not in danger of training a generation of both officers and soldiers who become so reliant on it that when it goes wrong there is nothing to fall back on?
Mr Jewell: I am not sure I am qualified to answer that because the Ministry of Defence is responsible for training. In terms of the systems themselves, certainly what I am advocating, and it is what I advocate within the Defence Technology Centre to the MoD, is that we should not be putting more and more information on the soldier. As you already said, they receive possibly too much and they get information rather than intelligence. What I am advocating, and what the SBAC companies are advocating, is the movement towards intelligent use, i.e. the role autonomy can play in that field we have already rehearsed earlier today.
Mr Barnes: The danger here is that there is information overload. What we have to do is ensure that the user gets the right information at the right time after sufficient networking to ensure that what is presented to him is confirmed and real. There is a danger of over-reliance on having that information but it is better than not having it.
Dr Smith: Another aspect of this is the importance of involving the end-user in the whole procurement cycle. We have seen much more of a shift to that, even allowing the SMEs access more easily and readily through recent developments like the Centre for Defence Enterprise. They have monthly meetings where industry can go and actually talk to the end-users and ensure that the systems are being tailored and designed and better meeting the needs of the guys on the front line.
Mr Richardson: In terms of information superiority, it is even more important with the nature of the conflicts we are currently engaged in with this asymmetric threat. There are no lines drawn with people lined up against each other so information superiority is absolutely fundamental. David said it is better than not having it. It is for the Ministry to determine the training regimes and what processes they put in place to make sure that information is exploited efficiently.

Q145 Mr Jones: Can I turn to the UK industry? In the memorandum BAE Systems states that the company staunchly supports the MoD's Defence Technology Strategy and it refers to it being world class. Could you tell us why it is world class and, on the other side, where it is not and some of the dangers from evolving technologies elsewhere?
Mr Jewell: There is no shortfall in the skills and competencies in the UK for autonomous systems development, whether that is in academia, SMEs or in the larger companies. Where there is a shortfall is presenting that as fielded equipment. That is clearly where we have the gap. There is, in R&T parlance, the valley of death: the gap between the low level technologies and then the fielding in the services and that problem of translating those at a higher systems readiness into operation. That is an area where we have struggled in recent times in investment not only in industry but across MoD as well. There is recognition of that, and the Defence Technology Plan, recently issued by the MoD albeit yet to be fully absorbed by us all, is a step towards trying to bridge that important gap in the priority areas which are affordable and we do support that. The capabilities do exist. Clearly not every single facet needs to be manufactured nationally nor indeed do all of those areas at a card and sub-component level.

Q146 Mr Jones: Where are UAVs in terms of the Defence Industrial Strategy? As I predicted, once Lord Drayson has left it has slowly been smothered before it actually grows up. Where is it in terms of that process? If we are, as you say, world leaders in this, one of the things with being a world leader is keeping one step ahead. A lot of the innovation is taking place in quite small university research projects or small SMEs. Where do the MoD see it in this if, for example, the Defence Industrial Strategy means anything these days?
Mr Richardson: It is in the air systems chapter. The commitment that MoD put into the Teranas programme was the manifestation of the commitment to the UAV UKAV space. I would say that it needs to be worked and it needs to be better defined than it currently is in all of the areas we have been talking about this morning.

Q147 Mr Jones: We are little confused and have to keep asking when the next chapter of the Defence Industrial Strategy is coming on board. What is your understanding of where it is at, not just in terms of the UAVs but overall?
Mr Richardson: Certainly at the last meeting of the NDIC that I attended three weeks ago it was still being developed, and as we know there is a review of the budget.

Q148 Mr Jones: It is being killed off by civil servants?
Mr Richardson: I cannot comment that it is being killed off by civil servants but it is wrapped up in the PRO8 budget round at the moment.
Mr Barnes: That is true. I think we lost track of it during PRO8 and we do not know where we are on DIS2 at the moment.

Q149 Mr Jones: That is quite concerning, especially if you are talking about an area like this which needs not just championing but also investment in terms of research and support.
Mr Barnes: It is a very great concern, yes. What we hope to have in the industry is consistency having made a policy statement.

Q150 Mr Jones: From the MoD.
Mr Barnes: From all government.

Q151 Chairman: When you say you do not know where you are on DIS2, would it be right to say that at every stage of the process of DIS1 you did know where you were?
Mr Barnes: Yes, I think that is generally true. We knew where we were in the earlier stages of DIS2 when there were certain announcements made. As to timing of further announcements on DIS2, that appears to have gone into abeyance but this is a personal position.

Q152 Chairman: Do any of you have a different approach to that?
Mr Jewell: Only in the sense to support the fact that without knowledge of the outcome of the PRO8, having a document before that which, in a sense, would have been potentially undermined was of no value to us. Therefore, we were supportive of the fact, although we would like it to be earlier, that the budget outcome needs to be known before DIS2 is finalised. It needs to be a deliverable document.

Q153 Mr Havard: I was very interested in your answer because I read the statement about how you fully support the technology strategy and I thought you might be able to tell me what it is. These things two things are very much related to each other and that is also suspended. The question about skills and maintenance is doubtless inextricably linked in NATS and your planning process about what you need for the future, how you spend in relation to it, you are in a bit of a quandary because there is a hiatus in these strategic views coming out. Would that be fair?
Mr Jewell: Would I like to see a clear strategy for the deployment of systems?

Q154 Mr Havard: Not just DIS but the technology strategy within it?
Mr Jewell: I do defend the changes to the Defence Technology Plan. I think that is a positive step forward. What it seeks to do is to see much closer alignment of MoD investment with industry investment, which is a very positive step forward. I accept that it is ahead of us rather than behind us and clearly I would have liked to be working on this five years ago, but given where we are I see that is a very positive trend and, therefore, we do support it. What we are looking for is clarity of direction and decisions to be taken.
Mr Jones: What it becomes, if we are not very careful, is a piece of paper and a document written that everyone can agree to but it is not actually delivering anything.
Mr Havard: The real strategy actually takes place by dint of doing rather than being.

Q155 Mr Jones: I know organisations can write strategy papers that come out of their ears. Most RDAs are wonderful at doing that. What people are actually interested in industry is where the investment is. Certainly there is talent in terms of skills and investment in the longer term and that is important. You can have all the strategy you like and a pat on the back that you have got it but unless it has actually been implemented it is not much good, is it?
Mr Jewell: I could not disagree. We are laying down considerable investment across the industry, significant sums of money.

Q156 Mr Jones: Your members are not going to invest in certain areas if they have to second guess what possibly might be in this document or know that frankly it ticks all the boxes and everyone can feel warm about it but it does not actually mean anything.
Mr Jewell: I agree, but the defence technology plan is one of the nodes, DIS2 is another and the procurement plan is another. What we need to see, in a sense, is all of those being consistent.
Mr Barnes: There are areas where it is being put into effect, and complex weapons is one of those. The new structure of DGW, which takes into account a new way of working within industry, is a direct result of DIS1 sustainability and affordability and is making progress.

Q157 Mr Jenkin: It might be easier to talk about the next twenty years. The Ministry of Defence is organising a consultation with industry about the next twenty years. How is industry involved in that?
Mr Jewell: The Ministry of Defence approached the trade associations when they launched the capability investigation and industry is now jointly working with co-chairs at various levels, I think there are six sub-groups. We are fully integrated working alongside supporting that initiative.

Q158 Mr Jenkin: What is industry looking for in the outcome of this?
Mr Jewell: That sense of clarity for the future direction and investment in programmes.

Q159 Mr Jenkin: Is the SME sector involved in this?
Dr Smith: Absolutely, yes, through the various trade associations, their representations and also through much more openness that seems to be coming from the MoD. I mentioned this Centre for Defence at Harwell. We are also getting dissemination of

information through structures like the Defence Technology Centres on what are feedbacks days. There was a day recently at The Queen Elizabeth Centre where we were able to engage directly with MoD and the MoD community. There are a number of mechanisms where the SME community does feel engaged in the process and that it has a voice and that it is being listened to.

Q160 Mr Jenkin: Could each of you give us a flavour or an example of the sort of thing that the Committee should be aware of in terms of the potential of the technology and the capability that we should be looking at for ten or twenty years time? What sort of clever things are we going to be able to do and does it cost a great deal of money or does it get cheaper?
Mr Richardson: Are we talking specifically about the UAV area or are we now talking about things generally?

Q161 Mr Jenkin: As we splurge into other areas, because the UAV is merely a data collection instrument.
Mr Richardson: I can give you an example of considerable investment in high altitude long endurance UAV capability, a hybrid satellite capability, that the MoD has been funding through DERA and now QinetiQ for many years which QinetiQ itself will certainly be continuing to develop and which we believe is very much the UAV capability of the future. It is strategic and it has a tremendous scope in terms of payload and range. It is a satellite which you can launch by throwing it off the arms of two or three soldiers so it has tremendous capability.
Mr Barnes: For me we are looking at across the board improvements to what the American's called spiral, improvements in capability. For me the most important area of that is information management handling and the key technology here is processing. It is an area where we in the UK really do have to look at our internal capabilities.
Dr Smith: I would very much follow that up. I see the greatest technology advances not being so much platform-based in the future but really in the increased use of intelligence, and that links inextricably with autonomy as well. I have seen a push very much to can we use the existing sensors we have or cheaper sensors and not to be reliant upon larger optics or more extensive devices. Can we use the benefits in the faster commercial markets of cheap electronics? The video game community has moved on dramatically and we can pull in lots of benefits from those kinds of areas much more quickly to exploit this kind of processing development. I would imagine in the next few years that is the area where we will see the greatest development.

Q162 Mr Havard: You say the barrier is about processing, analysis and that sort of stuff. Are these barriers intellectual skills or are we talking about physical stuff like supercomputers or the speed of computing capacity? Is it a thing that is the problem or is it the training of individuals that is the problem?
Dr Smith: I have not used the word barrier. I would not say there is any particular barrier. Obviously to improve the skill set in the UK would be a good thing to do but I think we are one of the best-placed countries in the world to offer an enormous skill set and we are building on an excellent basis. For the training and development in key engineering skills capturing at the pre-university stage is incredibly important.

Q163 Mr Havard: What do I need to be teaching 14 year-olds?
Dr Smith: From our biased opinion it would be in the areas of key engineering and technology and science and not to be scared to use the word "engineering". There has been a move away to calling it technology.
Mr Barnes: We should be teaching 14 year-olds that video games are not simply moving pictures. There is something behind them that really is a major technical achievement. They should try to understand what is behind the game and not simply what the game is.
Mr Richardson: There will be two problems: digital bandwidth will be a major problem, and supercomputing will be a problem in the sense that we are talking about information flowing wirelessly in an uncontrolled environment. In the age of supercomputing we will have to be even cleverer than we currently are about cryptography and defeating that threat.

Q164 Mr Jenkin: Looking at the war of the future, do we not have to reconcile ourselves to the fact that not only are potential State adversaries going to have this sort of capability and competing with us but quite low level even non-State adversaries? Hezbollah has used UAVs in Lebanon, for example, and as the technology gets cheaper and more available is this not an entirely new theatre of warfare that we are embarking on? To that extent, is it ever dispensable or has this become an indispensable part of our defence capability and do you have the confidence that the Ministry of Defence is going to fund it?
Mr Richardson: Situational awareness is indispensable, particularly in an asymmetric environment. Staying inside Red Force's decision loop is absolutely critical and the MoD, I am sure, will continue to fund whatever technology, whatever capability, enables them to stay inside that decision loop. That, at the moment, is at least partially UAV capability and I think they are making entirely the right call, but that may well change as the threat changes.
Mr Jewell: You raised the point before about what the future world looks like. In autonomy there are two levels of awareness: there is environment awareness, all of those questions of where am I, what am I, what do I need to do; and then there is self-awareness, the how am I. I think we will see significant advances in both of those fields which are

both hard and soft skills necessary. It will be those areas which will continue to hopefully keep us ahead of the pack in terms of the threat of the counter against us.

Q165 Mr Crausby: The memorandum from BAE Systems tells us that autonomy will be the way of the future. It goes on to talk about the freedom to independently act. It tells us that "The question for the UK is therefore whether it wishes to nurture a national capability ... or be beholden on generations of off-shore supply." Does the rest of the UK industry agree with the point that BAE Systems makes about autonomous systems?
Mr Barnes: As this is a BAE pronouncement, may I say we do agree with BAE on this. This is the way things are going, towards autonomy. We have to be in step with it and our future industrial wherewithal is based upon being there.
Dr Smith: For the small companies looking to exploit their technology I could not agree more with that statement.
Mr Jones: Does that not go straight smack bang in the face of where the defence industry is going in terms of international cooperation between different countries and companies? Is it not a bit schizophrenic for BAE Systems to say that as they look both ways. When in the United States they tell you they are an American company and when they are here they tell you they are a UK company.
Chairman: I think we are talking about the autonomy of UAVs rather than the autonomy of BAE Systems.

Q166 Mr Jones: You cannot have it both ways.
Dr Smith: Increasingly, certainly from a technology standpoint, this idea of plug and play and interoperability is becoming more and more important and whatever the system is, whatever the platform is, the technology can quickly be upgraded and put in place and that is more likely to happen with regard to electronics and processing than to replace the platforms themselves.

Q167 Mr Jones: That will be done on an international co-operation basis.
Mr Jewell: I am keen not to be drawn into a wider debate on this but to make the point that the competence that BAE Systems has in this area is vested in the UK. We have capabilities in North America and they are being invested separately, particularly in the land arena. The competence we do have is here, it has been invested here, it is British workers that bring it forward and, therefore, the question really is whether it is wanted. Of course that is for the customer to decide and they will tell us whether they want that or not. If they do not want it, then it will perish. Our position is that is a lost opportunity of revenue generation not only for BAE Systems but for the wider economy.

Q168 Mr Crausby: Does the MoD want it? That is the $64,000 question. Do they want an independent national capability or not? You make the point in your document that we should campaign with the MoD to urge them that that is what they should do. What is your view of their view?
Mr Jewell: I would argue that not only would you want a national strategy from the MoD on this area but we actually need a national strategy across the wider economy, and indeed within the SBAC we are working on a vision paper to try and get support for that.
Mr Barnes: Within DIS1 MoD played very strongly on sovereignty, the ability to use the systems in your own national interest without the interference of foreign governments. I think that was a primary requirement and it remains such, and because of that the MoD will want to procure, where possible, from UK sources.

Q169 Mr Crausby: Will they want to put their money where their mouth is?
Mr Barnes: I cannot say.

Q170 Mr Jones: This is absolutely nonsense. For example, Watchkeeper's major partner is Israeli. I am not against putting investment into this area, but the idea that this is going to be something separate and different from any other programme which is a movement in the defence industry and you are just going to have a UK badge thing is complete rubbish.
Mr Barnes: I can only go back to DIS1 which says quite clearly that sovereignty is an important consideration. Yes, Watchkeeper has high Israeli content but the air vehicles and the system will be made in Leicester and the innards of the system are known in great detail to those who build them.

Q171 Mr Jones: That is different. What you are arguing now, and I have a lot of sympathy with this, is you should have things built in this country, but the idea that you will have a system which will just be funded and researched and actually worked on by UK plc separate to other things is not the case. All your companies are actually investing in other European countries and North America and actually collaborating on joint projects. I have no problem with that personally.
Mr Barnes: What you are saying is not entirely correct. There are changes in the Watchkeeper air vehicle which are significantly different to those in the airframe that the Israelis use, the so-called Hermes 450 which is currently in service. They are there because of a UK requirement to meet UK needs.

Q172 Chairman: Do you have confidence that the issues of operational sovereignty identified in DIS1 are satisfactorily answered in relation to the Watchkeeper programme?
Mr Barnes: Yes, personally. You will have to ask Thales when they appear here for the detailed knowledge, but to my knowledge the sustainability requirements will be met in Watchkeeper.

Q173 Mr Crausby: It is an important issue that these things are manufactured in the UK but that is a different issue than whether we have national

sovereignty over it. I accept the fact that it can be manufactured in a joint way, both in the US and in the UK, but it seems to me that the prime issue is the MoD should have the ability to use these systems independently. Are the MoD moving in that direction?

Mr Barnes: There is a difference here between the satisfaction of a requirement through a UOR, an urgent operational requirement to meet an identified and current need, and that which goes into longer term planning for the defence capability. In the longer term planning context, I believe the MoD wishes to sustain its sovereignty. There is a major problem here with ITARs. There is a major problem in the knowledge of systems bought from overseas and the source code of the software used within them. That is something which, to my knowledge, the MoD wants to prove itself, but you would have to ask the MoD for confirmation.

Q174 Chairman: My impression of the Israeli and the American approaches to operational sovereignty is that they are very different. The American approach is based around putting a wall around its operational issues. It wants to keep everything within American eyes only, technology for American companies. Israel seems to be moving more in the direction of saying we have got these ideas, you can have these ideas and we will develop more. Is that a fair analysis?

Mr Barnes: With the Americans there are commercial overtones as well and I am sure they are there with the Israelis to boot. The Israelis are selling systems and clearly that is within their interests. I do agree that there is a difference, from my level of interpretation, between the way in which the Americans approach it through ITARs and other restrictions and the way in which the Israelis approach it through lack of willingness to deliver systems.

Q175 Chairman: Can I ask another question about autonomy. I was a bit surprised last week that in relation to maritime systems the Ministry of Defence witnesses we had in front of us said that it had been done, that UAVs had taken off from ships and had landed on ships, but the technologically was very complicated. Why is it so complicated? If you can have autopilots taking off from airfields, why should it be so difficult to develop the technology to do it from a moving platform on the sea?

Mr Richardson: There is a company that has quite good technology but unfortunately they are not a British company. They have perfected algorithms that can detect pitch and roll on a deck. That is the difficult bit, particularly also because, generally speaking, you are talking about vertical take-off UAVs as well and there are not many vertical take-off UAVs around. The combination of the instability caused by that particular engineering and that particular technology, and the instability of the platform that you are attempting to land on, the control algorithms are pretty smart to be able to do that.

Mr Barnes: We have, in fact, experimented with maritime recovery with a system called Scan Eagle which is made by a subsidiary of Boeing. It is recovered in a very novel way. It is a relatively small airframe which makes the whole thing more difficult but it can be done, and has been done, and is used extensively at the moment by tuna fishermen in the Pacific.

Mr Jewell: One of the factors is on a compact ship space is incredibly limited and, therefore, if you are looking for an asset which is going to have endurance then it will drive its size because of fuel and payloads. As soon as you get to that scenario, there is no ideal way of being on-board a conventional—we are not talking aircraft carriers here—naval vessel simply because of the layout of the ship. Small systems may be capable of operation and there are novel techniques to do that. Certainly within the Defence Technology Centre we have experimented with towing a recovery sledge with a seaplane, and the seaplane then drives itself into the recovery sledge and is then taken on board. There are ways around it but, as I say, if you are looking for long endurance and range from those naval vessels then that becomes a not insurmountable but a significant challenge with today's physics.

Q176 Mr Havard: Can I go back to something you mentioned about ITAR? We recently did the new trade treaty that came to us as a Committee to do. It has been agreed this end but has not been fully agreed the other end. Obviously we have had a lot of discussion in the past about ITAR. Under that new architecture, as I understand it, there are a lot of sub-discussions taking place around particular technologies and matrices and so on. You seem to be suggesting that the ITAR waiver process is still a current barrier. I assume these matters are being dealt with in those application arrangements for the new treaty. What discussions are you having about not just the technology embedded in particular platforms and systems but how all UAV systems are to operate in relation to navigational satellite aids in the future? Is that part of the discussion that is happening in terms of that technology debate and, if so, how?

Mr Barnes: We do have problems with ITAR, which I think is well known. I do not know the detail of your activities but I hope it makes it easier to get these agreements with suppliers, in the US in particular, to supply componentry—and it usually is at the componentry level—into UK systems which will not embargo its application, its use or resale.

Q177 Mr Havard: Is the component debarred because of the software algorithms within the component?

Mr Barnes: Sometimes, and sometimes because it is a particularly impressive technological achievement which the Americans do not want to release. I am using America here but it is not just America who would have such constraints on their sales of componentry; other nationalities also have not the same but similar restrictions.

Q178 Mr Havard: We know the ITAR process and you have mentioned the ITAR process. There are other similar barriers then, are there, to this development? If so, what are they and what should we be doing about them?
Mr Barnes: As a representative of a UK industry I would say we always have to be conscious of the potential problem resulting from ITARs when we use American componentry.
Dr Smith: It also works in the other direction as well when UK companies wish to get their technology out, for instance, to the US. It is just as difficult under the ITAR agreements even to open up discussions let alone export component technology.
Mr Richardson: We are investing in the UK in just about every sub-system area, every sub-capability area. The ITAR problem is not specific to the development of these systems, by which I mean that even if we had, as we do have, the capability within the UK we would still be buying and sourcing different components overseas so we would have the ITAR issues anyway in developing this capability. Simon's earlier point is the critical point. We have the capability, we have the science here, and we have the early technology readiness here but it is getting through this valley of death. That is where our competitors in the US and Israel have succeeded where we have not. They have actually applied it and that is why, if we wanted to put a system in right now off the shelf, we do have more ITAR issues than we might if we are allowed to continue to develop this technology.

Q179 Mr Havard: It seems to me, from all our discussions, it is now less and less a capacity and arrangements issue as a political issue as to whether people are going to release this information and collaborate. This moving away from having an architecture that can deal with it in terms of how business might relate to one another but the barrier is really political and not in terms of the mechanics of the process, is that right?
Mr Barnes: It is both political and commercial.

Q180 Mr Havard: There were severe process barriers before. The Americans had two men and a dog processing the paper. We have got away from the arrangement issues down to the nitty-gritty of it, which really is a political issue. Is that right?
Mr Barnes: I cannot say personally whether or not it is totally political. I think it is a combination of both. There are needs within the US to maintain political control over capabilities. There are needs also to maintain a commercial control over technological developments to preserve the advantage that American industry has in some areas of high technology.

Q181 Chairman: The MoD has told us that for the longer term the equipment capability customer has challenged UK industry to develop a common remote viewing terminal that is able to accept a full motion video feed from any UAV system. What is industry doing about this? Is the MoD putting incentives in the way of industry in order to encourage it and, if so, how?
Mr Barnes: I have views on the validity of full motion video and, in fact, we are doing work within an organisation called NiteWorks looking at the potential advantages resulting from full motion video. We have not yet, to my knowledge within Thales—and again Thales will be more informative on this when you talk to them—started working on any activity aimed at delivering full motion video-based RVTs into service.

Q182 Chairman: The MoD says that there is a need to improve the exploitation of the information and intelligence collected by UAVs on current operations by improving connectivity between separate systems. Is that right?
Mr Richardson: That is right. It raises another issue around the tasking and controlling of UAVs at both tactical and strategic level and some being tasked and controlled by the Army and some being tasked and controlled by the RAF, the different levels of crypto that are applied, the different operational requirements, the fact that many of these systems are UOR systems and, therefore, not designed into the overall ISTAR architecture, all of those things have to be sorted, and are being sorted out. The Ministry is very focused on sorting those issues out but they are issues.

Q183 Chairman: That is just operating within country but if we are operating with other countries as well?
Mr Richardson: It adds another level of complexity.
Mr Jewell: As you say, the balance between the required levels of security and the required levels of openness to transfer of knowledge and information is the trade that needs to take place. If you are operating across the top secret and the secret layer and the restricted layer in a coalition, then that becomes a significant negotiation.

Q184 Chairman: There is a bit of a sense of chaos here. Would that be correct?
Mr Jewell: I am not qualified to say that. We only see what we see in the press rather than necessarily see it firsthand so I do not know.
Mr Barnes: Interoperability remains a major consideration: different systems working to different standards where interoperability can only be secured if you buy the same system. This presents UK industry potentially with some problems where the parent system, the biggest deployed system, is probably of US origin.

Q185 Mr Jenkin: An issue that was raised earlier and which relates to interoperability and connectivity, the JAPCC, the NATO Joint Air Power Competence Centre raised two issues it regards as very high urgency: bandwidth and frequencies. Does UK industry share this view?
Mr Jewell: Yes. The next World Radio Conference, which is where the bandwidth allocation takes place, is in 2011. Whilst that sounds some way off, the

preparatory work for that is taking place now. It is managed by the Civil Aviation Authority. John Mettrop is the man on point. Collectively the industry is supporting that initiative in order to get the UK position established and the European position established which is then taken forward to the World Radio Conference. It is a significant investment and extremely important for us as well because without those bandwidths we will struggle in the future, not only in the military because of interoperability problems but also in the commercial exploitation.

Q186 Mr Jenkin: What is industry doing to address the problem? Presumably reducing the requirement for frequencies and bandwidth is part of the equation. What is the answer to this bandwidth and frequency problem?
Mr Jewell: You have summed it up. There is a requirement to reduce the level of bandwidth the transmission needs to and from the vehicle, but the frequency allocation is still essential and cannot be overlooked. Yes, industry needs to come up with systems which have low bandwidth needs and requirements, which is a balance of the autonomous capability in both the analysis component and also the collection component, but we cannot get away from the fact that we need both data link frequencies and then radio frequencies for control.
Mr Richardson: There is also a lot of work going into spectrum management as well.

Q187 Mr Jenkin: What do you mean by spectrum management?
Mr Richardson: Managing the spectrum more efficiently, so whatever frequencies are being used to manage the frequencies to hop to different frequencies at optimum points to get the most out of the available bandwidth.
Mr Barnes: A simple example would be frequency hopping: hopping from frequency to frequency within a spread, a technology which is employed in systems like JTIDS with which you might be familiar.

Q188 Mr Jenkin: All this begs the question these systems will be working fine while we are sort of low level, medium and high level counter-insurgency but if we are actually in a proper war international agreements about bandwidth and frequencies are going to be part of the warfare. There will be no agreements and presumably all these start falling over because we jam each other's systems.
Mr Jewell: That is the risk if you do not have a managed strategy. If you make the assumption that I will use this because I am either the aggressor or the defender, you could then find yourselves being jammed by something that you never imagined would be relevant: it might be a coast watch radar or some other system which is operating on a similar frequency. The bandwidth allocation is key and then securing that bandwidth to not be susceptible to somebody else's deliberate jamming is also key.
Mr Richardson: Those technologies all reside in the UK. I hate this terminology world class. What does that mean? In terms of the availability of the science, the science into the technology, and the technology into applications, it all exists in the UK. We are leading the field in many of these areas. It comes back down to the sustainability of that technology investment and the importance of the MoD keeping its finger on the pulse here and investing in the right areas for us to continue that technology lead.
Mr Barnes: This is a problem across the board and exists wherever transmission reception is involved. There are electronic counter counter-measures which, as Clive has said, the UK is very adept in, which can be applied to reduce the threat of the sort of jamming that you have just identified. That is a problem to UAVs which are controlled by signals either from satellite or from the ground.

Q189 Mr Havard: That is why I asked the question about navigational capacity as well, whether it is GPS or what the architectures are to control it. Presumably there is a relationship between these two things quite clearly. Is that part of this discussion? Is this discussion part of an international discussion that we ought to be dealing with BERR, the old DTI, whatever it is called this week? Where does that argument rest? The MoD are very important in that debate and I know they have been reserving parts of it. I have people telling me they cannot get mobile signals because the MoD will not do this, that or the other. Where does that argument rest because it is not just a military argument, is it?
Mr Jewell: No, it is very much across the piece. In order to have safe navigation clearly the systems are going to have a range rather than a single point solution so we would normally anticipate that GPS would be available. We would also expect inertial navigation.

Q190 Mr Havard: There are a lot of expectations.
Mr Jewell: The inertial navigation you can, because that is inherent. However, if you are flying a mission for 24 hours you cannot then be reliant on inertial navigation to bring you back to the point you thought you started from, therefore, there are other technologies which are being developed. Forgive me for diving down into the detail but there is something called SLAM, which is simultaneous localisation and mapping, and that is the ability of the system to self-determine where it is and, therefore, if it then loses its GPS feed it is able to re-navigate because it has knowledge.

Q191 Mr Havard: I do that with a map and a compass.
Mr Jewell: It is the electronic equivalent of that. They are capable if they were to lose GPS, or operate in a GPS denied environment: a tunnel, a cave, a building. We will expect to see a combination of those technologies to create the degree of robustness and airworthiness that the regulator would require.

Q192 Mr Havard: It is a key issue in terms of the operational activity of these assets once you have developed them. They can be as smart as you like but if they cannot fly and they do they not know where they are, they are in a bit of trouble.

Mr Jewell: I agree. That is why I was saying the balance between the UAV component and the exploitation component is essential. These are technologies that are being addressed in the UK as we speak.

Mr Barnes: Navigation is a key issue, most certainly, but there are ways of reducing the threat to navigation which can come either from jamming, as Dai has identified, or from American switch-off. As you know, there is a European proposal to develop a system called Galileo which works as an alternative to GPS. By the same token, there are ways on board the air vehicle, if it is air vehicle although it may be a ground vehicle, of reducing the impact of jamming by null steering in a very complex arrangement of aerials. There are measures to reduce the threat but GPS, or some satellite navigation system of some form, is very important to UAVs.

Dr Smith: A lot of the focus of the processing technology that has been developed is very much on passive operations, so if you do have GPS denial, for instance, the vehicle or the system is able to operate as effectively as possible. I can give you examples if you are interested in appropriate programmes that are addressing that.

Q193 Chairman: I said that we would come, at the end, to the issue of air traffic control and the fact that it is impossible, at the moment, to fly UAVs in other than very limited air space in the United Kingdom. What are the air traffic control issues that face the development and the testing of UAVs in this country? What is industry's view about the way the MoD is going about sorting out some of these problems?

Mr Jewell: The industry response to that problem is the initiative that we referred to called ASTRAEA and that brings together these 13 different investing bodies, seven from industry. What it seeks to do is develop capability across 16 different areas. Rather than going into all 16, if I can just boil it down. Firstly, there are three primary strands: one is the technology that is required for safe operation; the second is the evolution of the regulation, and in the UK that is CAP 722 which is the Civil Aviation Authority's document; then the third is demonstration, which is both about demonstrating to the customers that there is a capability in use but also to the general public that there is something which is acceptable and safe and that they would allow to operate. Within those technologies, sense and avoid is one of the critical technologies: a pilot has the ability to see and avoid. What an autonomous air vehicle would need to have is equivalence to that and, therefore, the equivalence of sense and avoid. There is no particular technology challenge, it just needs to be done, and those systems are being developed in the UK. We then have integration with the air traffic control system. Clearly that is a system which is currently controlled by people and, therefore, an unmanned vehicle will, in some way, need to be embedded in that either through the controller of the UAV or it could be the system. Both of those aspects are being looked at going forward. Then there is the whole area of secure communications and robustness in security around the system as well. Those are three examples of the 16 different areas. I mentioned before that is an industry and regional initiative. It does not have any Ministry of Defence investment in that but the Ministry nevertheless sits as an observer on the steering board and is supportive, but supportive short of money. We are looking for the MoD to commit resources into the next phase of the programme as part of their commitment to achieve the goal. The goal would be that by three years hence, at the end of this year, we would have the ability to go forward to the Civil Aviation Authority and certificate for safe operation in the UK air space.

Mr Barnes: I would add that this is an international consideration as well. I agree with everything Simon has said but for this to be totally usable we have to get international agreement also on regulatory clearance and on the approval of technologies.

Q194 Mr Havard: You also have to have sort of political acceptance. My colleague, Robert Key, is not here but his constituents around the Salisbury Plain might be a little bit agitated about the fact that some of these things might be weaponised as well. They are flying around the place and they might fall out of the sky. There is an argument to be had with the general population about the usage of these things as well, transparency and visibility and all of that argument, but that must play into the international dimension as well about what people might accept flying where. That has got to be a problem, has it not? What is the industry doing about trying to deal with that?

Mr Richardson: I have to go along with what Simon was saying about equivalence which is really the key. Unless we can demonstrate that we will not get public acceptance. We will have to demonstrate that it is equivalent to a manned aircraft at least, and probably going beyond that.

Mr Jewell: I did mention in ASTRAEA the third component was that demonstration in recognition that moving people's confidence on the capabilities of the system is absolutely key. We totally agree with you and that will take time. We often refer to the Red Flag Act going back to the 1860s with motor cars. It took close to 30 years before the motor car was accepted unfettered without the red flag or lantern. How long will it take on UAVs we do not know, but we know we will have to go through a similar period of adaptation.

Chairman: Many would say bring it back! Thank you very much for your evidence this morning. It has been very helpful to have the industry perspective on something that is clearly a very important issue in the future defence of our country. I am most grateful. I am just about to do something that I do not normally do which is to explain why I have a gavel sitting in front of me. I have a gavel sitting in

front of me because the cadets at the United States Air Force Academy at Colorado Springs every year adopt an exemplar, someone to whom they can look up to, a figure of history. The person they have adopted for the class who will be graduating in 2009 is someone called Colonel Hub Zemke who was very big in the Second World War and someone who was very close to the Royal Air Force in the Second Word War. He was a combat observer for the RAF and ended up, having been a fighter pilot ace, in Stalag Luft 1 as the senior Allied prisoner there. His descendants, knowing that the USAF Academy in Colorado Springs have adopted him as there exemplar, have provided for them a gavel, which is this gavel, which he used on family occasions. I do not know what his family relations were like but nevertheless they have challenged the USAF Academy to have this gavel used in various different places on various different occasions all around the world. It seemed to them, and it seems to me, that it would be appropriate to close this session of the Committee with the use of the gavel, which I shall now do.

Tuesday 3 June 2008

Members present:

Mr James Arbuthnot, in the Chair

Mr David S Borrow
Mr David Crausby
Mr David Hamilton
Mr Dai Havard
Mr Adam Holloway
Mr Brian Jenkins
Richard Younger-Ross

Witnesses: **Mr John Howe CB OBE,** Vice Chairman, **Mr Victor Chavez,** Vice President, Business Development, Sales and Marketing, **Mr Nick Miller,** Head of UAV Systems, Business Development and **Mr Chris Day,** Business Executive, UAV Systems, Thales UK, gave evidence.

Q195 Chairman: Good morning. I wonder, Mr Howe, if you could possibly introduce everybody?
Mr Howe: Good morning. I am John Howe, Vice Chairman of Thales UK; Victor Chavez, on my left, is our Vice President for Business Development, Sales and Marketing; Chris Day, on my right, is head of our UAV Systems operation; and Nick Miller on my far left is the Head of Business Development for our UAV Systems operation.

Q196 Chairman: Thank you for coming to give evidence on our inquiry into ISTAR, and UAVs particularly. Can you begin, please, by telling us how important UAVs and unmanned aerial systems are in terms of Thales's business; how important the technology is; and how you expect it to develop in the future in terms of the importance to you?
Mr Howe: I will start, if I may, and then I will turn to Victor. We do operate in Thales at several levels which are relevant to your inquiry about ISTAR, and about the role of UAVs in ISTAR. We are a prime contractor, a systems integrator, across a wide variety of platforms; and we provide a lot of high technology equipment and systems in the communications area; sensors; and in the field of ISTAR we provide systems including ones which are based upon UAVs. We believe we have particular strength in the integration of UAV ISTAR systems. We are at the moment, as I think you are aware, providing the Hermes 450 to the British Army in operational theatres; and we are the prime contractor for the MoD's Watchkeeper programme which will provide the UK Armed Forces with a persistent tactical UAV ISTAR capability for the future. I will turn to you, Victor, if I may to add to that.
Mr Chavez: I would just like to stress the breadth of Thales's involvement in C-4 ISTAR. Many companies have a C-4 ISTAR division, but if you actually look across almost all of Thales's divisions there are elements of C-4 ISTAR in there. That is because we are a systems integrator and an electronic systems provider. As John said, that goes from base technology through to being system of systems integrator on projects such as FRES, for example. In that context we are not a platform provider. To us a platform is merely a mechanism for getting a set of sensors and communication equipment around the battlefield to a particular location in space whereby we can gather the information that we need, we can process that information and we can turn it into usable intelligence for the end user. From the very outset we are a company that specialises in the systems elements of C-4 ISTAR, and the systems element of UAVs. I would just like to reinforce John's point on that.

Q197 Chairman: In the last evidence session I asked whether we were doing the wrong inquiry into the platforms, as opposed to all the other issues involved in UAVs. In view of your answer, Mr Chavez, what would you say to that?
Mr Chavez: I think it is interesting to understand the platform dimension. As we look at UAVs, you cannot have a UAV system without the UAV platform; and, therefore, the platform is an important part of the system, clearly. I think it is important to differentiate between those systems where the platform represents the highest risk element of a particular system and those where, in the case of ISTAR surveillance systems that Thales is involved in, the platform is a relatively low-risk element of the mix of the system and the innovation, and the complexity and the potential risk lies in the maturation of the sensor technology and the bringing together of a coherent system, rather than in the platform. So platforms do have an important role to play; and, it is very important to understand, particularly in the field of UCAVs, in terms of combat air vehicles, that the platform complexity tends to be greater; because what you are actually asking of the platform tends to be much more substantial.

Q198 Chairman: Of the three most recent urgent operational requirements two of the UAV ones were procured from the United States. Does that suggest there is a shortfall in British technology, or in European defence technology? Are British or European defence companies falling behind the United States? Is there something we should be doing to catch up?
Mr Chavez: I think if you look at the UAV systems market you have a distinct set of different layers of the UAV programme. When you look, for example, at the strategic end and you look at the bigger UAV systems, such as that which is used in the Reaper system, Global Hawk and so on, it is fair to say that the US has invested a vast amount

more than any other country in those strategic UAV systems. If you look at the middle level, where we see Watchkeeper and the Hermes 450, the country that has invested more and has greater operational experience of that than almost anywhere is Israel. You see that in terms of the US, because many of the US programmes, at that sort of tactical UAV level, are based around Israeli-originated designs. When you look at the small, handheld, man-portable UAVs you see it is a much wider market. Because of the scale of the UAV there are interesting platforms being provided by people almost out of their backyard and garages. It is not too far different from model aircraft technology; *and* you see strong usage by the US, strong usage by Israel and growing offers from around the world. In terms of the UK's knowledge, when we look at programmes like Watchkeeper, there is no doubt in my mind that Watchkeeper is absolutely state of the art. There is nothing in the States, I believe, that is significantly in advance of Watchkeeper. Watchkeeper, even though it was based originally on an Israeli UAV design, the system components, the communication systems, the sensor systems and so on are derived on a best in class basis from around the world: the data links, for example, very important in terms of international interoperability, are bought from the US; the radar system is being manufactured by Thales in the UK; so there is a wide range of systems issues that come together. In terms of the broader systems, I think the UK systems thinking is very advanced.

Mr Howe: On the point of platforms versus systems, in the case of Watchkeeper the actual platform is a relatively modest part of the total value of the system—round about 30 per cent, I recall from memory. Secondly, the vehicle for Watchkeeper, though derived from the Hermes 450 which is an Israeli product, is being developed and produced in the UK, in a joint venture we have with Elbit which is contracted to Thales. Even the air vehicle is at least partly a British development.

Mr Chavez: I think it is very important to recognise that right at the outset of Watchkeeper MoD placed upon us some fairly stringent requirements in terms of sustainability of supply of all aspects of the system in the UK, because obviously we wanted to ensure that the UK had ownership of the intellectual property associated with all aspects of that; and hence the creation of the joint venture, which is based in the UK, to manufacture and to own and to hold that IPR for the air vehicle.

Q199 Chairman: Do you have anything you wish to add?

Mr Miller: I can concur that the elements of Watchkeeper for the UK have put Thales and the UK in an excellent position from our current operations with Hermes. The UK, MoD and Thales on the industrial side have learnt a lot from those operations. Through Watchkeeper for the future we are now at the forefront of the UAV market and ISTAR market in the UK.

Q200 Mr Crausby: Hermes 450 UAVs are currently operating in both Iraq and Afghanistan. Can you outline what capability they are delivering and what feedback you are receiving from our own Armed Forces?

Mr Day: Today, if we look across both theatres (and I will speak generally about both theatres and specifics when we get to a particular point) we have now achieved somewhere in the region of about 9,000 operational hours, which is a significant total when we look at historic data. We support the MoD across a whole range of different types of operation. When we entered the journey, pretty much just over a year ago, the targets were tough and very difficult to meet; we had about six months to get this capability up and running, the regiment trained and ready to deploy; and more specifically, which has been one of the key areas that we have learnt probably most about, is the logistic support that we need in order to support our guys out in both theatres; and we have picked up an awful lot of information associated with that. We have to work closely with the guys because, at the end of the day, they are using it on average for about 14 hours a day—that is two air vehicles up each day for about 14 hours a day, every day of the year—sometimes for durations of 100 hours consistently. In order to support that we need to make certain that as the requirements on them change and evolve (and they will depending on how the operations are going) we can look at how we might reflect changes within a system, specifically when we look at Watchkeeper, in order to support those. One of the most significant benefits of this particular UOR—and in the MoD we call it "lines of development", so we mean the infrastructure, the training, the way they deploy them at CONOPS—we have started to learn very significant lessons out of these particular operations and how they might be reflected on Watchkeeper. What we are doing all the time is talking to the military; we are talking to our guys in theatre; and we must remember that we actually have a small team out in each theatre supporting the guys, so when there are technical challenges we are in a strong position to make certain that we can address those issues very quickly. From that perspective we are learning 24/7, and it is 24/7; every day of the week something else is coming back. We also get involved and we work closely with the regiment down on Salisbury Plain, attend regular meetings and we work closely together to make certain this thing works in the best possible way for the guys on the ground.

Mr Miller: This is a fundamental capability that is being provided. Feedback from operations have said that this is extremely advanced, and an enhancing capability. It provides full motion video; and an electro-optic and infra-red camera is onboard the unmanned vehicle, and provides that video and intelligence throughout the battlespace command for the land-based commander, both through forward air controllers, through remote viewing terminals or laptops, but also into the ground infrastructure in both theatres. So it is providing that battle-winning capability with electro-optic infra-red intelligence.

Q201 Mr Havard: You said 9,000 hours, on how many frames?
Mr Day: In each theatre we have five aircraft. Basically how that operates is we keep pretty much two ready to go all the time. That is spread over about four airframes. Occasionally when we have got vehicles down for servicing then we will use the three we have got.

Q202 Mr Havard: Each airframe will not have done an equal amount of hours, will it?
Mr Day: No.

Q203 Mr Havard: In the extreme, one of them will have been used more than any of the others; so you have got an extreme testing, have you, of one or two of these vehicles?
Mr Day: We keep very, very detailed logs associated with the air vehicles themselves, the ground stations, the data links and the sensors. We know exactly how many hours we have got on each of the platforms in each of the key equipments. In terms of the environments, that has been one of the most significant areas of learning for us all. I give you two examples: when we originally deployed the equipment into theatre last summer they pushed the boxes off the back of the aircraft into Iraq and immediately were met with 50 degree plus temperatures. Today that is outside of the specification of most UAV systems—clear to about 49 degrees. The moment we arrive—55 plus degrees—everything is thermally stressed. In Afghanistan one of the most significant challenges, although it is not immediately apparent, is that the whole country is covered in a very fine dust. What does that mean to us? It means with things like computers and laptops you have to clean filters twice a day. You can imagine, on a piece of high technology equipment that changes the way you want to do maintenance; it changes the way you want to support the equipment. We then wait five or six months and then we are trying to operate the same equipment in Afghanistan. Today we are now operating in temperatures of minus 10/ minus 15 degrees, significant humidity, so we are working in icy conditions. We are working in temperatures where people on the ground are actually freezing to death, and the system is up there pushing hard and it is delivering to the guys on the ground. Out there we also have issues I think the Afghanis refer to them as "the day of a hundred winds", where up in the mountains the winds are over 100 miles per hour for days on end. The guys have got to plan and be able to operate and use the equipment in those environments, and that is where Watchkeeper comes in. Watchkeeper was designed from the outset to actually address those types of environments and give our guys the best possible chance when those conditions exist.

Q204 Mr Havard: That is why you are testing off the coast of Wales, no doubt! Have some of these airframes been in both environments?
Mr Day: At this moment in time we do not generally move platforms or equipment from one theatre to the other; but we actually keep a very detailed log of the equipment in both theatres. We identify all the issues that arrive, and we do have the ability to pull information about the system as it is located in both theatres.

Q205 Mr Crausby: In a recent article in *Jane's Defence Weekly* you said that Hermes 450 was initially seen as a collector of intelligence, but the company was "widening what it can do and moving out to full network connectivity". Can you tell us what that means, and what the benefits and the future will be for UK Armed Forces personnel?
Mr Miller: The Hermes 450 system is basically a collector at the moment of image intelligence, and provides the basis of that intelligence to the land component. What Watchkeeper brings as a system is much more of a dissemination, communication and network system. What we are learning from the Hermes 450 is how we grow that path towards the full integrated system where the information is passed throughout the intelligence. Hermes is a collector; is providing the right imagery, down to the right ground operator at the right time; but the next step forward is to pass that information to all the necessary players across ground infrastructure, across air vehicles, across all the different land component commanders. There is a difference between the collector system of Hermes and the Watchkeeper system of the future; which is why the ground infrastructure is so important in Watchkeeper.

Q206 Mr Holloway: What are we actually doing? How are we using it in Iraq that is different from Afghanistan? Presumably in Iraq it is mainly for intelligence; and presumably in Afghanistan it is being used far more for targeting?
Mr Day: In Iraq today its predominant role, as you rightly identify, is just intelligence; and a lot of that is gathered pretty close to where the guys are based around Basra. Effectively it feeds its imagery straight into the main operating base, straight into where the commanders require it. In Afghanistan the CONOPS, the way the military use it, are different; in that it has several roles. It performs a similar role to that in Iraq, but it has the additional roles of supporting our guys when they enter complex and difficult scenarios. The greatest attribute of a UAV is to give the commander on the ground a bird's eye view of actually what is happening on the ground. The vast majority of operations will request that the Hermes 450 is over the top and giving that information. The way it works is, we have the ground station back in Camp Bastion, which could be up to 150 kilometres away, and they are responsible for mission controlling it, and they will actually receive what we call the primary information, the primary imagery. That is linked via several networks into the commanders that are fundamentally in command and control of the operations. They receive that pretty much real time, within just a matter of a second or so. Where it gains

its most significant value for the British Army is to the guys that are actually in contact. How we can provide support to them is they have something called a "remote video terminal", which in reality is just a television screen, a manned, portable television screen with a simple antenna; and those guys on the ground are actually seeing what the aircraft is actually doing overhead. They get a clear view of what is going on in compounds. They get a clear view of what is going on over the hill. They get a clear view of what is around the corner. For the guys just about the enter that difficult compound, not knowing what is around the back of that wall, what is likely to be hiding in the corner, they get a clear view before they actually enter that building; and that is fundamentally one of the key roles that Hermes 450 is fulfilling at this moment.

Q207 Mr Jenkins: I understand, I think, but could you make it clearer for me. I get the feeling that the bigger the platform we produce the more stuff you are going to bolt onto it until the thing will not fly, and then you take the last bit off and it flies. When I see these soldiers coming out with the little model aircraft and sending them up and around, that can go around the compound and take pictures and send the pictures back. Of all the platforms we have got and are developing, I did not realise the Hermes 450 was called the 450 because it weighed 450 kilograms, so that is a big machines and we can bolt more bits on. What does the military want; what can they use; what is the bottom line? Is it a full video streamed down; is it infra-red? What is the machine and platform that would take the necessary capability? If you take us from the small one, through Hermes to Watchkeeper, will you tell us why each one is important and what it actually does and try and make it so I can understand it?

Mr Day: I will start, if I may, and take us on a journey from the small, the mini UAVs. We have only got two effective capabilities in theatre. We have only got two air vehicles on the Hermes 450 that can be used with operations. They tend to use those for the more complex operations. At the end of the day, there is a lot of activity going on by the guys in the infantry who are walking the ground who actually want to know, in very quick time, what is immediately ahead of them. That really means they have got to have command and control of it themselves. They have got to be able to hand-launch it. He wants to know what is 200 metres down that road; so he hand-launches his little UAV and within 25-30 seconds he knows what is ahead of him. That is what the mini UAV gives him. It gives him an ability to have command and control, and for him to actually be able to use that air vehicle to gain that information extremely quickly; but it places constraints on the system. It means it has to live with the infantry, the guys who are actually walking the streets on the operation. He cannot push around a 450 kilogram air vehicle; he needs something that can live in his pack—and that is where minis come from. When we are talking about operations in urban environments, built-up areas, little mini UAVs are absolutely the right thing to have. The key message to get across there is the mini UAVs can normally have a daylight sensor, just like normal televisions at home, or a thermal imager; they cannot have both. They do not have the ability to lift both sensors. If it is night-time you have got to sit there, break it apart and put a thermal on it. If it is daytime you put the TV on it. The other thing is, because they are model airplanes, and if any of you have seen model airplanes fly, they are not very stable; so the imagery is not particularly good, but it gives you the snapshot, and it gives you that bit of information that may make a difference. As we go up the tree, the big driver for moving from minis, to slightly larger platforms, to a Watchkeeper, is all about the quality of the imagery and the range at which we can operate it. Now we are talking about a sensor that is very stabilised, that can sit and look at my face for 12 hours of the day; it can move very quickly through the environment, perhaps a speed of 100 knots, perhaps less. The little minis do 30 or perhaps 40 knots so they are a lot slower. The big platform also has the ability to carry other sensors, and the one I would like to talk about is something we call "synthetic aperture radar". What that really means, it is a radar that gives us an image that looks pretty much like something you would see on a television; it gives you an image. The real attraction is, when there is cloud most television cameras cannot see through cloud—no ability at all; you can leave your air vehicle on the ground—cloud, fog or mist, no capability at all. You put synthetic aperture radar on it and it sees through cloud; it gives the guys a clear image of everything that is stationary on the ground. We then link it to another bit of technology that allows us to see everything that is moving on the ground. Those radars weigh about 40 kilograms as a minimum. The moment you say to me, "Chris, we now want to have that imagery in those poor conditions", I need a larger platform to lift it in the air. I am talking about lifting half a man. I cannot do that with a mini; I need a bigger platform. You can start to see that the critical variable with UAVs—that is the air vehicles themselves—is the more payload you want, the larger the air vehicles. I have a little equation in my head that says, "Depending on your payload size, the payload you represent is between ten and 20 per cent of the platform mass". If you want a 40 kilogram sensor you probably need an air vehicle of about 400 kilograms. The more sensors you want, the more capability, the larger the general platform. The other driver that links to things the Americans do is they like to fly higher. Little mini UAVs, those poor little television sensors, they are only good from about 300 or 400 feet to a 1,000 feet above the ground; if you fly higher than that imagery is not very good. You might say, "I want to fly at 5,000 or 10,000 feet", but you need a better sensor, so you move into the Hermes system. If you have then got a very large platform like the Predator, the Reaper or the Global Hawk, they operate at significantly higher altitudes, and one of the reasons is they carry a very significant sensor sweep. They have to operate higher in order to keep them safe. Those are the sorts of variables which define where you pitch your UAVs.

Mr Chavez: Just to add to some of the key variables, Chris touched on persistence—the ability to remain on-task for very extended periods of time—when you are actually gathering intelligence you will frequently want to watch one locality for 24 hours a day: you cannot do that with a mini UAV. The other thing is to do it in a totally undetected manner. You need to get your UAV up to an altitude where it is not visible and it cannot be heard; and, again, mini UAVs just cannot do that. Things like Hermes 450 and Watchkeeper are designed to operate so you can see and gather very usable intelligence without being detected at all for very extended periods of time. You can watch that building and you know that the white Mazda that drove in has been parked there, a person got out, nobody else has gone into that building and then he gets back into the White Mazda and he drives off 12 hours later. It is that sort of long-term persistent ISTAR that is very important.

Q208 Mr Holloway: It might be very interesting to visit Mr Day's team when we are in Afghanistan if there is time. Mr Miller in his excellent article referred to "imagery exploitation". Just quoting from Mr Day again, in Afghanistan is there a conflict with the use of this kit between, for example, the JTAC teams that are in contact and the higher commanders who always want to know exactly what is going on? Also, to what extent can the troops in contact dictate or request where the machine should be looking in order for them to get rounds on the ground from indirect fire weapons or aircraft?

Mr Day: In terms of the overall way the MoD uses their CONOPS, this is another driver behind the way that the MoD has structured UAVs with the minis, the tactical and the more strategic; that, at the end of the day, Watchkeeper or the H-450 is a brigade or a battle group commander's assets. Basically what will happen is the commander will say, "You have that asset for the duration of that particular activity". So there is no conflict with higher commanders wishing to take it away. It has been dedicated to that commander for his particular operation and he has command and control over it. The way that it operates at the moment: at the end of the day it is about the guy who is in contact; it is about the guy who wants to look inside that compound; and the way he achieves it is through things like our Bowman communications. He has a means of talking back to the HQ to say, "Okay, guys, the aircraft's not in the right position; we're not seeing what we want. Can you move it left a little bit; right a little bit; or, will you hold on where you are?" That is basically how the commanders in the field use it today. If, as a consequence, a higher priority issue came along and there was a debate and they said, "Look, guys, we've got a more significant issue happening elsewhere and we want to redeploy your assets", what might happen is the commanders in the field would default to their minis and accept the penalties of the poorer imagery and the shorter range.

Q209 Mr Holloway: The JTAC teams then effectively have to talk the surveillance asset onto the target in the same way in the old days you had to talk aircraft onto a target. In the development of Watchkeeper, is this a kind of thing you might try to integrate? If so, are there likely to be any delays? I would have thought it is quite important to give the guys electronically on the ground some way of positioning it in the right place and then calling for whatever they want?

Mr Day: People often ask me the question, "What is the difference between 450 and Watchkeeper?" It goes back to the Chairman's first question actually, which is: how do we find UAVs? Is this the right question we are asking? UAV aircraft have been around for a fair amount of time and we have a pretty comprehensive understanding of them. One of the key differences for Watchkeeper is how we integrate the whole system into the rest of the UK infrastructure, the COMMS, the air traffic management, the logistics chain. That is what Watchkeeper brings to the UK. Today the MoD is looking at various ways of achieving that. One way is that most commanders in the field have a Bowman radio of some form or another, which is both the voice and the data. One of the things we have been looking at, and working with MoD on, is a guy can have a simple map display of exactly what is going on, with a clear lay-down of who is where and what is going on. That guy can tap on that screen and potentially say to them, "I want to view that particular geographic point on the ground". He can then identify where he wants that to go, which could well be the Watchkeeper ground station, and that information is then sent back via the Bowman network to the guys in the ground station and they can react accordingly.

Q210 Mr Holloway: In the future it is likely that we will be dealing with rather more sophisticated enemies than tribesmen in southern Afghanistan. To what extent are you putting on equipment and ensuring that people could not electronically disrupt our UAVs in the future? Obviously you will consistently update it, but is it a consideration now on the equipment we are getting, in case we have to move it from Afghanistan to somewhere else?

Mr Day: Watchkeeper itself when it was originally conceived was thought about as 15 years for the platform and 30 years for the system life. We had to consider that, like everything else in the military domain, as people understand the technology they find ways of countering it. We have done things within the system to specifically make certain that, as these issues arise—and I will give you one particular example—on Watchkeeper the data link is encrypted, so it has got a high grade encryption on that which will inhibit some of the very issues that you mention. Also, in addition, we have done some clever things with the data link to effectively bury it in the noise within the ether, rather than make it stand out like a particular electromagnetic lighthouse. We also look carefully at things like the noise it makes; and we pay particular attention to silencing the engine. We look carefully, and we will look carefully, at the next evolutions at how we would use all its signatures. Yes, you cannot enter the UAV field today expecting that your technology

is going to last particularly long. You have got to make certain that as you understand as an organisation, and this is one of the key strengths of Thales, we do have a significant knowledge base, across a significant area of technology, we can pull that into these sorts of programmes and give us a future-proof solution.

Q211 Mr Hamilton: Are there any additional things that Watchkeeper does you have not already mentioned which are better than Hermes 450?
Mr Miller: This is really key. There are two elements of Watchkeeper that are different from the Hermes. There are the advancements in the air vehicle itself; and of course there is the network ground infrastructure which we have been talking about. The air vehicle itself is a dual payload configuration, so it can take the EO/IR camera as well as the radar together—electro-optic and infra-red—and additionally more sophisticated SAR GMTI radar. It has an all-weather operational capability; so it has de-icing systems built in. It has got enhanced structure integrity with an adapted wing fuselage construction. Autonomous flight capability and auto take off and landing. Of course, the additional maintenance and access to subsystems is improved. The advanced duplex avionics on board and the enhanced landing gear. So there are many aspects within the air vehicle of a significant difference. On the ground infrastructure side you have got the exploitation, communication dissemination that we discussed as a fundamental difference of the Watchkeeper system; and of course dual data links; the ability to pass information securely around the battle space. All this is required because Watchkeeper has got to provide a worldwide capability. Armed Forces can be deployed anywhere in the world and in climate conditions that are different from current theatres. Of course it has got the ability to be flexible for additional operational sensors in the future. You can see we have built into the growth future of Watchkeeper not only the air vehicles but also the ground network enabled infrastructure.

Q212 Mr Hamilton: At the evidence session on 6 May we were told that the MoD was fairly hopeful that the in-service date would be achieved towards the end of 2010. Are you confident that is going to be achieved?
Mr Day: Yes, today the programme is on schedule and we look to deliver the capability into MoD on that date.
Mr Miller: We are very pleased actually because, since our Contract award in 2004, we have achieved the design phase; we have been through all the critical design reviews throughout 2006/07; we have met all the milestones for the Watchkeeper programme; we have achieved our first flight of the new Watchkeeper air vehicle in April this year; we are now starting the integration phase and testing; it is currently going on and will eventually come to the UK at Aberporth at the end of this year, beginning of next year, ready for the 2010 in-service date as planned.

Q213 Richard Younger-Ross: This is obviously a great advantage for our Forces, to have this ability to see behind walls. Even on a simple basis it cannot be long before even in a place like Afghanistan that Afghani forces should not have their own device which will try to spy on our Forces. If we come across a more sophisticated foe then certainly they will have UAVs to spy on our Forces. Are you developing countermeasures against UAVs for spying?
Mr Chavez: Perhaps if I take that as a question because it relates to broader military capability. Certainly one of the developing threats that Armed Forces see around the world is the threat of UAV systems being used widely against them. The traditional response to that comes from enhanced air defence systems. Thales, for example, in Belfast have been responsible for modifying the Starstreak air defence system to adapt it to work with smaller radar across section targets, because UAVs do present very difficult targets because they are so small; they have very small amounts of metal in them, so they are very difficult to see on radars, and missile systems, because of their size, find it difficult to hit them. The traditional response is to actually look at upgrading your air defence systems, and that is what we have been doing using the Starstream missile.

Q214 Richard Younger-Ross: The sort of foe we may face which we are trying to use UAVs against would have the same difficulties in trying to detect you?
Mr Chavez: Absolutely. The survivability issues, as Chris touched on with Watchkeeper, have been very carefully thought through. Indeed, when you actually come to mission planning—because you do not just launch a UAV and pilot it, typically with Watchkeeper one of the major advantages is that you can actually set the mission plan—you are not flying the aircraft round the sky, but saying, "I'm interested in surveying this area of land", and the aircraft will go off and it will steer the sensor, rather than you fly the plane. It will automatically go off on that track. There is a lot of automation in how we extract that information.

Q215 Chairman: Just a brief question about trialling the Watchkeeper and flying it in UK airspace. Are your discussions with the Civil Aviation Authority going well? Is there an issue about delay or anything in terms of the extent to which you can trial the aircraft?
Mr Howe: Could I comment on that. This, of course, is a subject on which it is the MoD, rather than us, which is leading. The MoD, as I understand it, is putting together a proposal in relation to air space which it is in discussion with the CAA about. We, of course, are very interested in the outcome of that; but we are not, as it were, the sponsor or owner of that process. As I understand it, there is a fairly elaborate process for considering changes to air space arrangements; the CAA is quite well advanced with that. The next stage, I believe, is public

consultation about the sort of solution the MoD has been proposing. I believe that is likely to start quite shortly; I do not know precisely when.

Q216 Chairman: But you would not describe it as a significant clog in the process?
Mr Howe: I do not think so, no. It is a significant issue but I do not think it is a clog in the process. I think it is being addressed sensibly and very methodically and thoroughly, and we will get through the process.
Mr Miller: There are two aspects: this is permanent airspace change which is being discussed; but you can at the moment fly in temporary restricted airspace. For instance, in 2005 we flew the Hermes at Parc Aberporth in a temporary restricted airspace; and we could do that now if we wished in consultation with the CAA. There are two differences between what we can do now—controlled and permanent air space change that John was talking about.

Q217 Mr Hamilton: You indicated, Mr Chavez, that Israel has developed the Hermes 450. Will the UK be able to maintain and upgrade the Watchkeeper as we move forward; and will we be able to work independently?
Mr Chavez: Absolutely, and that was entirely behind the reason we created a joint venture in Leicester which holds the intellectual property.
Mr Howe: Held here in the United Kingdom. Watchkeeper is being built in the UK, whereas Hermes 450 is an Israeli product.

Q218 Mr Jenkins: One thing that strikes me, Chairman, is that you have built this new Watchkeeper platform that you bought in bits and pieces: why did we not go for the American Global Hawk? Is that not a better platform? Would it not have carried all your sensor equipment? If we had got the basic platform from America the deal with have been done now, and it would have been trialled and proven airworthiness, and it would carry the loads you want of Watchkeeper. Why did we go down the Watchkeeper route?
Mr Chavez: They are very different classes of UAV and they are rather different. The Reaper UAV is much more similar to Global Hawk. It is quite clear, the Watchkeeper competition was an open competition. There was a competition with UAV systems offered by Lockheed Martin, Northrop Grumman and BAE systems as well as ourselves; so it was a truly international competition against the Watchkeeper requirement. It comes back to this: there is a significant difference between how you use these three different levels of UAV. It is an operational concept issue.

Q219 Mr Havard: On that point, what about weaponising this thing; because then it does become a very different vehicle, does it not; and the point about its use and airspace becomes a different set of questions. In summary, we are having bits of material flying about that might bump into one another, but if they have not got explosives on them it is less of a problem than if they have. Is it able to do that? Reaper does that; is Watchkeeper going to do that?
Mr Howe: If I may, I think that is really a question for MoD rather than us. We are not under contract to provide a weaponised UAV. We are providing an intelligence gatherer. Obviously vehicles that can fly could well have the potential to carry weapons; but we have not been contracted to do that—that would be in the future. The question about the military requirement is for MoD rather than for us.

Q220 Mr Havard: Should it be needed to be done it would be capable to do that in that way in the future, would it?
Mr Howe: I would not care to answer that directly. I should not be at all surprised. It is a capable aircraft, which is capable of carrying things. It can carry reasonably heavy payloads for surveillance purposes; it can carry payloads for other purpose, I have no doubt.

Q221 Mr Crausby: The MoD acknowledges that there are shortfalls in the direction, processing and dissemination side of ISTAR and your memorandum tells us that there is a strong value for money argument for the Watchkeeper system "to provide the basis for the UK based NEC Ground Infrastructure exploitation and dissemination capability". Could you tell us something about that? To what extent could the Watchkeeper Ground Infrastructure address the shortfalls; and is the MoD showing an interest in your proposals?
Mr Chavez: I am more than happy to discuss it. Just to come back if I may, Chairman, to labour the point slightly about the issue of exploitation of information and the difference between things like Hermes 450 and Watchkeeper. Hermes 450 is like having a satellite TV feed coming into your home, and you can watch it on the screen and, if you want, you can record it to your hard disk video recorder and so on. If you actually want to come back and say at a later date, "I actually want one frame of video out of what I've recorded in that programme two hours ago", then it is quite difficult to find it. If you actually said, "Okay, my neighbour wants that, and he wants to do it from his house", you cannot do it. Watchkeeper is actually more akin to taking that stream of data and logging it into databases so that you can actually retrieve all of that data at a later date; in the same way that you type into Google "I want a picture of the Houses of Parliament", and you come up with lots of images of the Houses of Parliament. Under Watchkeeper you can actually say, "I'm interested in this particular area and I want the latest data of information that was taken", or, "I want it between June 1 and June 3 2008". Anybody using the system, anywhere on the battlefield, can do that sort of retrieval over the very low data rate communication systems that exist on the battlefield. That is the reason why actually setting in place Watchkeeper will allow a huge increase in terms of responses to commanders' requests for intelligence. At the moment so much data is stored but it is not easily accessible; it is not easily catalogued; and it is

accessible typically through one system. Watchkeeper provides a distributed information system where any number of users can access all of that data. Watchkeeper at the moment, the ground information infrastructure is really designed around the various sensors that are going to be on board Watchkeeper—the electro-optic cameras, the infra-red cameras and synthetic aperture radar; but there is nothing to stop that being extended to the information that comes off another UAV, a Reaper UAV, or off a Global Hawk UAV, or using different sensors. If you were to add in communications intelligence sensors or electronic support measures which detect signals, there is nothing to stop you actually using that information infrastructure to share that information. That would fulfil part of potentially the requirement known as DABINETT. As the MoD lodged in its information memorandum, DABINETT is certainly one if not *the* highest priority ISTAR programming in the eyes of MoD; because at the moment MoD has got quite a lot of collectors of information but it has not got in place the infrastructure to really get best value out of that, and that is why there is such a high priority at the moment.

Q222 Mr Holloway: Could you use Watchkeeper for locally disrupting enemy communications? Could you mine this data you referred to in order to identify threats, probably against a slightly more sophisticated enemy, but using specific bits of military kit?
Mr Chavez: In terms of disrupting enemy communications, there is nothing to stop a UAV platform, such as Watchkeeper or indeed the Hermes 450 platform, being used as a jamming system to disrupt communications.
Mr Miller: The systems are modular and can adapt different payloads. At the moment we have a requirement for electro-optic infra-red and radar for Watchkeeper; but of course in the future there will be additional payloads of that nature and others coming on board -hyperspectural links communications infrastructure links; so it is an adaptable system with a plug and play facility. That is the essence of these UAVs.

Q223 Mr Holloway: Mining the data?
Mr Chavez: Mining the data, certainly there are a number of tools; and indeed Watchkeeper will come with a number of tools to help target recognition and so on.

Q224 Mr Jenkins: I read occasionally about the automatic nature of the systems now developing. I see them in civilian life, but can you give me an example of where you think this automatic system would improve the intelligence, the decision-making procedures?
Mr Day: Potentially one of the most significant strengths of UAVs is that we all think about flying a UAV around with either a joystick or perhaps just clicking several positions on a map and the aircraft flies around, and that is fine; that is great for conventional mission planning; but actually we must never forget that the sole purpose of that air vehicle being up there is to collect imagery and the primary piece of equipment is that sensor; putting that sensor at the right point on the ground. One area of automation is, the guy does not actually dictate where the aircraft is going to fly, he just says, "I want to see that point on the ground with the sensor". He marks the ground and says, "That is a sensor point", and the air vehicle works out how it maintains that sensor on that point on the ground for as long as he may wish. That is one clear area. The other thing is, at the end of the day if he wants to cover a certain area, he might say, "I don't want to watch a point on the ground; I want to cover a whole specific area". When you are up there you have got winds from difficult directions; the aircraft does not want to do it in a particular way; you can just say to the air vehicle, "I want you to carry out an optimised path over that whole area", and it will sit there and work out exactly how it is going to fly that sensor across the ground in order to effectively survey that whole area. There are these little smart tools, but it is linked into the flight control system, that allow the system to effectively be more autonomous, be smarter but, very importantly, to take some of the load off the guys who are sat in those ground stations for many hours on end.

Q225 Chairman: May I ask a question which arises out of a memorandum we have had from L3 Communications UK which says that, "There needs essentially to be a mix of assets, some of them manned, some of them very large, very high, some of them much lower, but with manning in the loop in much of the system". Would you agree with that? Does there need to be a broad mix in order to provide the best intelligence capability that you can?
Mr Day: Without a doubt, and I go back to the statement I made earlier about the massive payloads. If we want some of the very complex payloads that we are alluding to in terms of being able to jam COMS and various other bits and pieces then you are talking about payloads that are very significant, and that actually need real time control, not through a data link but by a man sat in a seat on the actual platform. When you are looking at some of these very complex fused sensor suites, yes, you do need a mix of manned and unmanned to make that happen today.

Q226 Mr Havard: Can I ask a question I have asked of others, which is about navigation. This dual location business, whether it is shooting your very difficult single target that is running away, or whatever it is, this thing has got to navigate somehow or another. It is not going to have a map and a pencil, is it? If somebody denies you various capability, either GPS, all the rest of it, where are we with that? We depend on operational sovereignty, so what resilience is going to be built into these things so they are still going to operate on a range of systems, Galileo or GPS or whatever it is?
Mr Day: We were very aware at the outset of the Watchkeeper journey about the fragility of GPS, which is where the world is going to. We have them

in our cars; we have them in our passenger aircraft. We are well aware there is a fragility there. At the end of the day, when our guys most need this capability for it to be denied because of a simple jammer or whatever was not acceptable. As we discussed earlier, future-proofing Watchkeepr, what are we going to do to get around this? There are techniques to get around that. A lot of work done in the US has been looked at. There is a lot of work which has been done in the UK. We do have instruments onboard the aircraft that allow us to hold position quite accurately. We have the ability because, at the end of the day, we are looking at a data link which could be seen effectively like a radar. You can use the data link to give you some positional data. There are ways of getting around it. The key message I would like to get across I suppose is that we were aware of that sensitivity ten years ago, and we have made certain that Watchkeeper will be one of the few UAV systems in the battlefield tomorrow that can actually support ops should that particular condition exist.

Q227 Chairman: I think we ought to move on. Thank you very much, Mr Howe, to you and your team for a very helpful briefing. You have brought it to life in a way which has been most interesting. Thank you for your evidence.
Mr Howe: Thank you very much, Chairman.

Witnesses: **Dr Graham Thornton,** Managing Director, Northrop Grumman UK, **Mr John Brooks,** President, Northrop Grumman International Inc, **Mr Ed Walby,** Business Development, HALE Unmanned Systems, Northrop Grumman Integrated Systems gave evidence.

Q228 Chairman: Good morning, Mr Brooks. Are you the boss?
Mr Brooks: My name is John Brooks. I am the President of Northrop Grumman International, and it is truly an honour for us to be here to talk to you about UAVs. It is a subject that we have been focussed on for about 60 years, and we look forward to the dialogue with you very much.
Dr Thornton: I am Graham Thornton, the Managing Director for Northrop Grumman in the UK. Lest you think we are just an American company visiting today—we have 700 employees in the UK and about £400 million of sales into the MoD; and we have some key programmes like the AWACS aircraft support and the Cutlass unmanned vehicle for bomb disposal. So we are in the UK and have been for many decades. I thought I would give that as a background, but my colleagues are principally here obviously to talk about a US-based capability.
Mr Walby: I am a retired US Air Force Colonel. I am Director of Business Development for Unmanned Systems in San Diego for Northrop Grumman, primarily Global Hawk. In my last assignment in the Air Force I was the first commander to take Global Hawk into combat as a technology demonstrator that converted to operational deployment.

Q229 Chairman: Thank you very much for coming to give us a United States perspective. I am well aware, Dr Thornton, of what you said about Northrop Grumman having a significant British presence as well. Your memorandum says that in the United States use of UAVs has already been widespread, whereas the Ministry of Defence in the UK is just making it a strategic priority. Does that imply that the Ministry of Defence in the UK has been a bit late?
Mr Brooks: I certainly have no expertise on which to comment on the Ministry's progress, but I would point out to you that in the United States we have benefited from some period of time and some very large investments of dollars which have enabled us to field some of the advanced capabilities that we will talk about today. Perhaps the point that we would commend to you is that, because of the very close relationship between our nations, in essence the UK has the ability to capitalise on these investments, and that indeed may be a legitimate strategy for the Ministry to take.

Q230 Chairman: Yes. This may be a question which applies to all defence issues, but there must be a gap in view of the spending of the dollars you are referring to between what the United States is doing in UAVs and what the British are doing in UAVs, and because of the size of the dollar gap presumably that gap is widening. Would you agree with that?
Mr Brooks: I would focus more in terms of the capabilities that we are working to generate—and you heard some discussion earlier of the different levels of technology and the different missions. The United States I think is investing in some of the higher end capabilities, the more advanced capabilities, and particularly investing development dollars there. Perhaps what we may see in MoD is investment in capabilities that may allow them to capitalise on those capabilities rather than duplicating the development investment.

Q231 Mr Crausby: In April you won a contract for the US Navy's BAMS programme which offers a marinised version of your Global Hawk UAV. Can you tell us what sort of capability the marinised version of Global Hawk will deliver? Will this UAV be required to operate from ships?
Mr Brooks: No, sir, it is a land based capability, capitalising on the extraordinary capability of Global Hawk to go very, very long ranges and search very large areas. Just as an example, in the US we say that one Global Hawk is capable of searching the entire State of Illinois in a single mission. That may not be terribly useful to you and perhaps I could offer that the combination of England and Wales are about the same volume as the State of Illinois; or, to put it in a operational context, if we think back to the horrific tsunami in the South Pacific of a few years

ago, one Global Hawk is capable of surveilling the entire region affected by that tsunami in one mission. We take that basic capability and then customise it and optimise it for maritime surveillance. I would ask my colleague to offer a few thoughts on how we went about customising it for maritime surveillance.
Mr Walby: Just to clarify in terms of the capability of the sensors that the Air Force carries, John's analogy to England and Wales or the State of Illinois, it actually has the ability to image every square inch of that territory, not just survey it. That awesome capability that was part of the US Air Force requirement was to carry electro-optical infra-red radar imagery, as well as signals intelligence collection, which includes communications intelligence and electronic intelligence. Those together met a need of the US Air Force. The Navy's requirement was to take it one step further; because in the Air Force's requirement set that I was a part of in the development when I was in the Air Force was essentially a land based operation where you would be moving from friendly territory into enemy territory; whereas the Navy's requirement was based on a 360 degree view and protection of the carrier battle group and battle space in the littorals. Their requirement was a 360 degree continuous presence in terms of the sensor field of view. What they are offering and have accepted with our BAMS programme, Broad Area Maritime Surveillance programme, is a 360 degree EO/IR system, and a 360 degree radar system, and at some point some form of electronic intelligence collection. Their requirement had to be 360 for continuous tracking of vessels and things on the sea. Global Hawk has been designed to be, as John has mentioned, modular and tailorable to whatever sensor capability you wish to add.

Q232 Mr Crausby: The MoD does not appear to have a requirement for a maritime UAV. Does that surprise you? Is that in some way linked to the difficulties with operating UAVs from ships? Can you tell us something about that?
Mr Brooks: No, I do not think it relates one way or another to a ship. We do in fact have an advanced rotary wing UAV that has already demonstrated the ability to autonomously land and take-off from ships at sea. If you go back to the beginning of the United States Air Force Global Hawk programme you will find that it was after the extraordinary power of that capability was demonstrated that other nations began to express interest and engage in dialogue and, in a few select cases, were given the authority to pursue that platform. We anticipate that with the US Navy's selection of this platform international interest is rising; and we expect further dialogue on that capability which, in this case, will only be made available we would anticipate to countries in which there is a strong relationship of trust and partnership.

Q233 Chairman: A rotary wing UAV that can land on ships, is there a United States requirement for that at the moment?
Mr Brooks: Yes, sir, there is. The United States Navy has that requirement initially for a class of ships known as the "littoral combat ship", because it would allow them to project sensors over the horizon as they examine areas in the littorals. They have recently expanded that to include other classes of ships and it can operate from any ship which is helo-capable.

Q234 Mr Jenkins: How big is Fire Scout?
Mr Brooks: It is a highly adapted version of a Schweizer small manned two-person helicopter. That provides you essentially a size in rough approximation. We could put one probably here in the middle, if we were to displace the ladies!
Chairman: Which we would not dream of doing!

Q235 Mr Holloway: This is probably not a line the Chairman wants us to go too far down, but can I ask Mr Thornton, could you, in your company, provide a sovereign, more capable product to the UK than Watchkeeper for less money?
Dr Thornton: In principle, yes. The sovereign aspect, by which I take it you mean UK based intellectual property, that is a model we have used and created already or have it in programmes, so it is not an issue. The only question mark is on ITAR but that will be replaced by the ratified Defence Treaty. We have a long record of defence technology into the UK, so that may not be a barrier. Have we got the right vehicle? Yes. I take the point that the Thales' representatives made that there are really several classes of air vehicle, and I think Global Hawk at the high end gives you total area coverage, admittedly down to great detail, but can you afford multiple Global Hawks to do the sort of role you are doing in Afghanistan, no, it is not appropriate, so you need a medium-sized model. In principle, we could supply that.

Q236 Chairman: Dr Thornton, from your knowledge of British military requirements, do you believe that there should be a requirement for a maritime or marinised—there must be a difference—UAV?
Dr Thornton: As long as one does not say marinated!

Q237 Chairman: Indeed.
Dr Thornton: Over the last two years I have been with the company I have made a very strong personal push to have Fire Scout recognized, and perhaps accepted by the MoD coastguard fisheries protection people. We have gone so far as to have discussions with the BT Group in relation to the River class of vessel. What Fire Scout does give you is flexibility, because you can afford more of them. You can have ship-borne operations with Fire Scout without the need for pilots, it is an autonomous vehicle. It has a long endurance, eight hours plus. It can carry all the sensors we have been talking about earlier. It has about a 600 lb payload (nearly 300 kg). Is there a need for maritime surveillance? Yes, because particularly in areas such as the Straits of Hormuz in the Gulf of Arabia one needs forward-looking sensing for any group of ships. There is no

point in taking ships into dangerous areas if there are small rubber boats with dangerous people and payloads on board. The short answer to it is there is a need for maritime surveillance on board all classes of vessels. Fire Scout is about a 1.8 tonne vehicle and will fit in a very small box on the stern of most UK ships even down to offshore patrol vessels.

Mr Brooks: There is one more point I would add, sir, which I think warrants some thought, and I offer this not as an answer but to generate perhaps some thought and discussion for the future. That is, we are very used to the requirement to maintain complete situational awareness of what is happening in the airspace around our nations and our areas of interest. We really would not think in this day and time of not having that kind of capability. I believe that you will see in the future that nations such as yours and ours will be seeking the same thing in terms of protecting our sovereignty and of those areas we are vitally interested in in ensuring we know what is happening on the seas surrounding us. I believe that is one of the core reasons why you will see many other nations start to express more and more interest in this BAMS Global Hawk maritime surveillance because it provides that capability.

Q238 Chairman: In view of the capability that you describe, it seems astonishing that there are still many problems along the Mexican border, that still pilots can go missing in Nevada and not be found. Why is that?

Mr Brooks: I would tell you that as a nation we are still coming to grips in terms of political and policy decisions on the best way to maintain sovereignty, to surveil where appropriate and to bring the right tools to bear. The question is not whether the tools exist the question is the most effective way to bring them to bear in both a network function and a policy function in terms of civil liberties and so on. In the case of our borders, there are some borders that are very long and if we choose to surveil those it will require a capability of both speed and sensing, so that you can visit and revisit in appropriate times, and that means a high end type capability. In terms of other borders, you may elect to use a more tactical asset that allows you to maintain a full motion video on a key crossing or key area, but we are still working through those policy issues and how to bring them together in the network as a nation.

Q239 Chairman: You would say they were more policy issues than technology?

Mr Brooks: The basic technologies exist. The networks in terms of how to bring it together are still being developed just as the policy issues are being addressed.

Q240 Chairman: Mr Walby?

Mr Walby: Yes, I would like to add to that. About last November the Air Force announced at Beale Air Force Base in central California, which is the home base for Global Hawk, that they were going to co-operate in a way that is relatively new with regard to civil authorities and customs and border protection in the United States, and they were going to look into employing Global Hawk on the northern border with Canada, which is a more porous border than the southern border, but do it in a way that the aircrew that fly the aircraft for training would use those borders as training missions, so you would get double bang for your buck. You would essentially patrol the border and operate in exactly the same way as you would operate in combat but, of course, the end solution would be different in terms of what you did with that information and how you collected it. There is a movement to use the system in a training environment, but for use as customs and border protection.

Q241 Mr Holloway: BAE referred to autonomy as being "the way of the future". What do you think they mean by that and do you guys share that view?

Mr Brooks: I believe we absolutely do share that view. Part of the value of our 60 years of focus and more than 100,000 UAVs of one sort or another is the development of fully autonomous vehicle management, which we now have on Global Hawk, on Fire Scout, and which will be a key part of our UCAS programme, an advanced demonstrator for the Navy. Again, I will let Ed speak to it because he has experience as a U2 pilot and commander understanding the challenges of actually flying the aeroplane and having commanded the first fully autonomous air vehicle.

Q242 Mr Holloway: What do you mean by "fully autonomous"?

Mr Walby: Global Hawk has a computer system onboard, a multi-computer system onboard, and the pilot uses a mouse and a keyboard. He clicks the mouse for taxi and a little window pops up and it says, "Do you really want to taxi now?" and you go "Yes", and it taxies. The pilot then communicates, it stops at the runway and when he gets clearance for take-off he hits the take-off button and the aeroplane replies with, "Do you really want to take off now, yes or no?" and it moves to the runway and flies. His control is not a joystick or rudder paddles or a throttle, it is communication with the computers on board. As a U2 pilot my primary and focused attention was on keeping the aircraft flying straight and level, pointy-end forward, and at the altitude and air speed it needed to be. Because of that, all of my attention was flying the aircraft and I had very little involvement with the execution of mission. Obviously as I ran low on fuel I would tell everyone I was headed for home. In Global Hawk, through our first trials in Australia when we did a demonstration and later over Afghanistan, we discovered the pilot became a significant element of the execution of the mission. He sits right next to the sensor operator. What made that combination unique was the fact that the air vehicle would fly, stay airborne, and the pilot had little focus of attention on his attitude indictors but he also was involved in four chat rooms in which he communicated with the intelligence folks who were doing the exploitation, troops on the battlefield, commanders in the combined air operations centre, and his tasking and process of employing the asset was not automatic but very

human interaction based on the requirement of that moment. It was designed to be completely autonomous from take-off to landing, completely hands-off if that is what you wanted to do. We did not realise back in the mid-90s that we would have so much interaction and so much human involvement in the prosecution of the entire mission centre.

Mr Brooks: What it allows us to do is focus not on how you do it because the aeroplane knows how to fly, it knows what to do at any given moment, it flies itself. It allows the entire crew to focus on the value of what it is you are trying to accomplish. Perhaps that is a good definition of "autonomy". It is not autopilot. There are those who define "autopilot" as autonomy. Our systems know what to do at any given point throughout an entire mission. The first major overseas deployment was executed with one mouse click from take-off to landing 28 hours later and at every point along the way it not only knew what it was supposed to do, it knew what to do if something went wrong and, absent a new command from you, would execute that.

Q243 Mr Holloway: It is probably at rather a low level, but in the UK we are investigating the sort of military requirement we might have over the next ten or 20 years. Are you guys involved in that? What sort of future capabilities do you think the UK might want? For example, I do not know whether Watchkeeper is autonomous. How might your company fit into that in the future given that we have gone down the route with Thales?

Mr Brooks: I will start and perhaps each of my colleagues may have something to contribute. I can tell you that for some years we have maintained a continuing dialogue with the RAF, for example, on the advanced capabilities that we are working on, not just the ones fielded today but those that we are working on for, as you would suggest, late in the next decade or perhaps in the 2020 timeframe. Your Chief of Air Staff, Sir Glen Torpy, has maintained a continued interest, has come to visit us and chats with us frequently and, again, perhaps as we talked earlier, is assessing what is happening and trying to decide if these technologies which the US is investing in may have application for the UK in years to come. There is some involvement and we would certainly welcome more.

Dr Thornton: On the subject of ISTAR in the future, along with RAF support we conducted a fairly comprehensive exercise on Salisbury Plain last October where we took some Special Forces personnel, an RAF regiment pretending to be the Army, and some Air Force assets, including C130, the Tornado, and Nimrod, and we actually did what was described as being the future for Watchkeeper. We actually fused the data, transmitted the data to users on the ground. We took Special Forces camera imagery back up to aircraft. The Tornado was acting in a close air support role, so it was given targeting information, real-time video back to its cockpit up to 100 miles out from the target so it could see what it was supposed to be aiming at on the ground. That exercise was set up in a matter of weeks. We were able to adapt the system during the trial, it was very flexible, and right now the MoD, particularly the RAF, is considering preparation of an urgent operational requirement which will see that capability fielded in Afghanistan. In essence, if you listen to the description of the Watchkeeper in the future it does that internet in the sky, if I call it that, now. I think the RAF wants to field it and it is certainly part of the DABINETT thinking.

Q244 Mr Holloway: Given the persistence, resilience and, I guess, endurance as well of the UAVs, has anyone ever looked at the possibility of putting nuclear weapons on them?

Mr Brooks: Some of our UAVs do, in fact, employ weapons. Hunter, which is a tactical UAV, perhaps in the same broad class as the ones that were previously discussed but an earlier generation, employs weapons. We have demonstrated the ability to employ weapons from our Fire Scout and that is both its Navy and Army configurations, because the United States Army has selected it as its rotary-winged UAV, will be part of the capabilities developed. As you get into the higher end, the Global Hawk type, that really is a policy decision. As I think the Thales gentlemen said, there is nothing inherently about the aircraft that prevents it from being used that way but the United States Government to this point has indicated because this is capable of operating over such large areas, for over-flight and basing reasons it views it right now as in our best interests to declare it to be an unarmed aircraft so that it has access to airspace that otherwise might be difficult to gain.

Chairman: Because this is an ISTAR inquiry, I do not really want to get into nuclear weapons or heavens know where we will stop.

Q245 Mr Jenkins: Dr Thornton, did I miss something insofar as when you had the exercise with the RAF, which platform were you talking about using?

Dr Thornton: We put our main server onboard a C130, but all of the aircraft assets, the ground assets, individual soldiers with PDAs, were networked in together and the data was managed accordingly. We did not change any of the communications links, we did not change any of the configurations of the platforms, it just got overlaid and did not compromise their performance. It did do this process of taking real-time imagery and directing it to people on the ground.

Mr Brooks: This capability he is talking about is platform agnostic. It does not care what platforms are there. It is a capability that we have developed, among other things, to help with managing bandwidth, but we demonstrated it to the MoD because they had indicated this ability to share data quickly was something that they were interested in.

Chairman: We will come on to bandwidth in a few minutes.

Q246 Mr Hamilton: This is on the direction, processing and dissemination where the MoD seems to be content with the "collection side" of the

ISTAR and the UAVs. However, it acknowledges that there is a need to improve "the way the collection of information and intelligence is directed and the resulting data processed and disseminated." Is this also an issue in the United States? If so, how is it is being addressed in the United States?

Mr Brooks: Yes, sir, it is an issue. If you had US officers sitting here I think they would express similar thoughts to those which you have heard from the MoD. I would tell you that these capabilities have to advance in harmony and that, as we demonstrated, the extraordinary power of persistence of a platform to not be episodic and pass over an area every great once in a while, but to maintain surveillance on a broad area for 24 or more hours, does place new demands, particularly on the exploitation system but also on the dissemination system, and it will require some level of manning and particularly some new tools to help automate that so that it can move forward. That is not to suggest that we should constrain our ability to collect down to what may currently be our ability to exploit. I am reminded of a story almost 200 years ago in my nation when someone brought forward for the first time the repeating rifle and it was initially rejected by the Army because they said, "Our soldiers will shoot themselves out of ammunition in a few minutes and then we will not have any". It was wiser heads that prevailed and said, "We can find a way to make more ammunition. We need to capitalise on the capability". We are moving in that direction but it does have to go forward in harmony so that you can capitalise on it.

Mr Walby: We encountered it early on in the war over Afghanistan, but what we were able to do as techniques were developed was we took an intelligence group and attached them to Global Hawk electronically in that as it collected and processed that imagery it was immediately exploited. Then as we progressed further we did some experiments on how we archive that information and now we are to the point where the information that is collected is archived, categorised and posted on secure websites for individuals to go and retrieve what they want to retrieve. The requirements of the collection may be dependent on a particular day but the information collected may be relevant to the next day's mission or the next hour's mission. All of that is at the hands of those throughout the distributed system who have access to those classified websites. We have even taken the server on board the aircraft which was the mission recorder and replaced it with a 1.4 terabyte server and connected that to a field radio so that a troop on the ground can literally reach up and pull and retrieve right off the Global Hawk. That is a capability that could be platform agnostic as well. Because of its altitude, Global Hawk tends to be a place that you can connect with other nodes. On the archival of that information, we flew a Global Hawk in combat for a year and collected every single image on that server and it only got to about 70 per cent full, so you have got the entire library of those images on board that system.

Q247 Mr Holloway: I know nothing about the angles or the definition of pitch, but could you use this for facial recognition, for example?

Mr Walby: I do not think that would be appropriate for Global Hawk. What we have discovered is what we refer to as layered ISR. Global Hawk's advantage is to search a broad area, pull up potential targets and pass that on to other systems. That may employ something like facial recognition, something that is closer and easier to get the finer detail.

Q248 Chairman: In what sense did you use the word "appropriate" there? Would not be possible?

Mr Brooks: I do not think we can comment on that in this forum.

Q249 Mr Havard: I just want to ask a question. You said you ran this exercise and people had PDAs on the ground and you were talking about a field radio that could communicate. The field radio is what I am interested in, what the infantrymen carry. Are they very specific or could they be integrated into the Bowman system? Are we going to have infantrymen again with half a dozen bits of kit all trying to communicate?

Dr Thornton: The whole point about the exercise we did was it would communicate through existing channels, including Bowman.

Q250 Mr Havard: So it is software technology?

Dr Thornton: It is a software system that recognises the communication link, what is at the other end of the communication link in terms of the screen resolution you might have, and it feeds the appropriate data rate and data resolution down that communication. We are not talking about changing the communication technology or the hardware, we are not changing anything on board the aircraft or the land vehicles for that matter. It is a method of archiving and tagging information for retrieval and, as I say, being able to be agnostic as to what platforms we are using.

Mr Walby: In the case of the server that I spoke of on Global Hawk, it is a small element of software placed on laptops and PDAs for the troops. It would take me probably three hours to learn how to use it but it takes a young marine about five minutes because it is an environment he is used to and it is based on Google search software.

Mr Havard: I have got a godson like that.

Q251 Chairman: We all know what you mean.

Mr Walby: It is very, very convenient.

Dr Thornton: Chairman, I am sorry, I have been passed a note due to my ignorance. The radio referred to is in service in the UK.

Chairman: Okay. We will now move on to industrial issues.

Q252 Mr Borrow: In October 2006 the MoD published its Defence Technology Strategy and in that document it states: "the UK is world class in several aspects of UAS/UAV technology and systems development, including the areas of sensor payloads and synthetic environment based

operational concept development". The Committee would be interested to know is that the view of the UK industry held in the US, and by your company in particular?

Mr Brooks: Without trying to get specific, which probably would not be appropriate, there certainly are areas in which we view technologies in some UK companies as advanced, as leading edge. There are some cases where we have entered into discussions about perhaps capitalising on that capability. We are in a world environment now where no-one has a monopoly on the best capabilities and we will serve our forces and our national security best by reaching across transatlantic boundaries to capitalise on the best capabilities and put them together and offer them to those who are trying to protect us. Yes, there are some areas in which we think the UK capabilities are as good as any.

Q253 Mr Borrow: In your memorandum you stated: "the UK remains a critically important market for the company as a supplier base and a source for technology partners", which is in another form of words what you have just said to us. Do you see the UK's position in terms of its industrial base in this area as something that is deteriorating or under threat, or do you remain confident that it will remain as robust as it is at the moment?

Mr Brooks: I do not bring extraordinary expertise to that debate, but if I were to look at it holistically as an outside observer I would offer that I think there are areas, perhaps the previous discussion on Watchkeeper and so on is one, in which there has been substantial investment. There has been a reference to DABINETT which provides an opportunity for British forces to capitalise on the sum of all knowledge being generated within a coalition or allied operation and import data from not only sovereign systems but allied systems, such as Global Hawk and some of the others. I do see investment and I do not have the qualification or the expertise to really critique that.

Q254 Chairman: Dr Thornton, do you have anything to add to that or were you hoping not to answer!

Dr Thornton: I certainly have a view. For the Committee's benefit, I spent 31 years teaching engineering at Oxford and being involved in start-up companies and technology generally. It comes down to affordability. It is one thing to use sovereign capability in a phrase rather glibly, but you have to define "sovereign" for a start, and I suspect most people know that most of the chips in our avionics on military aircraft come from Malaysia. How sovereign is that! I remember Mrs Thatcher answering questions about high explosives a long time ago around the Falklands War. Affordability is the word that ought to be in front of everything, affordable sovereign capability. Frankly, you get what you pay for. Is the quality of the engineering education system in industry and transition technology good, yes, it is very good indeed, we are well-known in the world for being very innovative. We have a little bit of a hiccough when we try to exploit but there is no shortage of innovation and investment in the UK in new technology, I do not think. Somebody has just got to map out what we really mean by "sovereign capability" and can we afford to be the best, because there is no point in fielding second-best, particularly in a coalition situation. If you have a sensor that is only half as good as somebody else's they will tend to use the other guy's better sensor, it is just commonsense, so maybe we should become a niche player in certain technologies so we really are leading edge and stand up to proper benchmarking against the best. In the area of electro-optics and radars, UK stands out amongst the best.

Q255 Chairman: Those are the areas which you would recommend us to move to?

Dr Thornton: It is not an exhaustive list clearly but I just pick that out of the air as an area where I know we do very well technically. I will not say world leading, that is difficult to say.

Q256 Mr Havard: Can I ask your advice on that. What the MoD says in the Defence Technology Strategy is that we are good, and it gives examples, "including the areas of sensor payloads and synthetic environment based operational concept development".

Dr Thornton: That is a fair statement.

Q257 Mr Havard: Is that right? Are those the areas we should continue to concentrate on or are there others we should become more capable of? If we cannot do the whole list, what should be the list?

Dr Thornton: That would be my first choice. Somebody said earlier in the previous session that the platform is a little bit less important than what you put on it. In the area of data handling, data processing, intelligence, creating information out of that data, what do you need? You need brain power and a computer, you do not need expensive test facilities such as you might if you were developing large scale missile systems. Are there other areas? I think in the area of chemical, biological, radiological sensing, my previous company, Smiths, is undoubtedly a world leader in that area, witness its sales into the US Department of Defence. There are pockets around the UK. I think it is quite instructive sometimes if you analyse UK companies that are exporting currently into US defence programmes that is normally a test that the Americans have had to come here. The area of health and usage monitoring onboard aircraft, the Chinook system that Smith's did, again that is onboard the F35 and was a UK developed technology in the South of England backed by DTI grants and so on. Without me trying to create that list, I think the list can be created in terms of what is currently exported, and Cobham Group and Ultra all have high levels of defence exports. You have to ask the question, why is the US Government buying those technologies to put on its leading edge platforms. At the sub-system level there are some very strong areas.

Mr Havard: We are waiting for DIS 2 or whatever it is going to be called and the technology strategy that comes with it, but when we get that, Chairman, perhaps we could have some input on that?

Q258 Chairman: That might well be something that would be helpful.

Dr Thornton: I would like to do that. I always say that every menu should have a price with it.

Mr Brooks: I would offer one addition there and that is in some sense we have focused a lot on the technologies of collection but, in fact, what is collected becomes most useful when it is actionable, so that some focus on the ability to capitalise on ISTAR or ISR is value-added and it is capitalising across a broad mission set. We focus a great deal today on getting a key piece of information to a soldier in a specific place at a specific time, perhaps going back to the facial recognition question you asked, but that is not the only challenge that those who risk their lives to defend us will face. There is an almost inevitability that at some time in some place, somehow, they may face more advanced threats and need to be able to quickly understand broad thrusts. For example, if we go back to the combat phase of the Iraqi conflict, one Global Hawk airframe identified and targeted, according to US Air Force public statements, almost 40 per cent of the entire Iraqi armed force. That is a tremendous amount of information to gather, understand and rapidly move to those who can take action to deal with those threats and the technologies to do that are of value here and everywhere else.

Q259 Chairman: I said earlier that we would come back to the issue of bandwidth, which your memorandum says is one of the major technology challenges for UAVs. To what extent is that a major technology challenge in the United States? How are you dealing with it?

Mr Brooks: It is, in fact, a major technology challenge. It is this issue of you are blessed with richness, you now have the ability to collect non-stop persistently across all of the spectrums essentially day and night, good weather and bad, imagery and electronics and signals and, therefore, something has to be done to make that useful. The current approach is largely a push approach to collect it and push it into the system where it can be dealt with. That means we have to expand the bandwidth available. There are also different ways to approach it in terms of concepts of operation. If I can use the analogy, at your desk today I suspect you have access to an almost infinite amount of information across the internet. You do not pull all that information into your hard drive, you define what it is you are seeking and your computer offers you a catalogue of what is available and you choose from what is on that catalogue and say, "I believe this is what I need to know" and then you pull that information. In essence, that uses much, much less bandwidth. We believe that the approach for the future should include both some technology that allows us to push greater volumes of information across the bandwidth and tools and procedures that allow us to make most effective use of the bandwidth that we have. That was really a part of the purpose of the demonstration that Dr Thornton talked about earlier that we did at Salisbury Plain, to show how SAS troopers could understand the catalogue of what is out there and say, "I only need that piece, give me that one".

Q260 Chairman: Yes, but that is a matter of education, is it not? I know I make far too little use of the computer power available to me because I fail to understand how I could take advantage of it, and I suspect that would be true of almost everyone.

Mr Brooks: I believe that is accurate.

Chairman: Any further questions? Gentlemen, if I may say, thank you very much indeed, it has been a fascinating tour through the differences between the United States and the United Kingdom and also the advantages and benefits of working together. Thank you very much indeed for your evidence.

Written evidence

Memorandum from the Ministry of Defence

The Committee would be grateful for a memorandum on ISTAR which addresses the following questions:

— What is ISTAR?

Current ISTAR capability

— Which equipment programmes provide or support current ISTAR capability? The Committee would be grateful for a list of these equipment programmes.

— What is the cost (acquisition and support costs) of the equipment programmes which provide or support current ISTAR capability?

— How do the various equipment programmes which provide or support current ISTAR capability contribute to the achievement of Network Enabled Capability?

— How are the equipment programmes which provide or support current ISTAR capability, and the outputs from them, integrated? How is the various information from ISTAR assets pulled together?

— Where does the output from ISTAR assets go—at the Strategic, Operational and Tactical levels?

— How does the MoD assess the operational benefits of ISTAR?

— How does the UK integrate / co-operate with its key allies with regard to ISTAR?

Future ISTAR capability

— What is the MoD's future plans relating to improving ISTAR capability? The Committee would be grateful for a list of the programmes in the Equipment Programme which are to provide or support future ISTAR capability.

— Which of these programmes are priority programmes for improving ISTAR capability?

— What is likely to be the future role of UAVs in relation to ISTAR?

ISTAR is a key military capability that generates and delivers specific information and intelligence[1] to decision makers at all levels in support of the planning and conduct of operations. The ability to convert information into intelligence that decision makers can act upon is a crucial aspect of the capability. ISTAR can be characterised as the co-ordinated direction, collection, processing and dissemination of timely, accurate, relevant and reliable information and intelligence. This process is of course fundamental to Network Enabled Capability[2] and specifically, for example, to targeting and the integration of military effects, situational awareness (and hence Combat Identification and the minimisation of the risk of fratricide) and force protection. Complex terrain and agile adversaries, for example, increase the requirement for capable ISTAR.

ISTAR capability can be generated at all levels of military operations. At the lowest tactical level it consists of individuals using their eyes and reporting what they can see, so equipping them with binoculars and a radio can significantly improve capability. At the strategic level it involves the collection and analysis of a complex range of information from maritime, land, air and space-based platforms. Low level tactical ISTAR assets (for example, thermal imagers) are organic to maritime, land and air formations where ISTAR is secondary to other functions such as targeting. This Memorandum focuses on the dedicated capability and assets employed to provide ISTAR at higher levels of command and those tactical assets with a primary ISTAR function.

Current ISTAR Capability

The Armed Forces have available to them a wide range of ISTAR capability covering all operating environments, although each capability is not necessarily constrained to operate exclusively in a single environment. Output from ISTAR is of course used extensively in Joint operations. Current capability can be broken down into the following broad categories and in each one the main equipment systems involved are identified.

[1] Information is unprocessed data of every description which may be used in the production of intelligence. Intelligence is the product resulting from the processing of information concerning for example threats or areas of actual or potential operations. The term is also applied to the activity which results in the product and to organisations engaged in such activity.

[2] HCDC Inquiry—Defence Equipment—MoD Memorandum Q15 submitted on 23 January 2008. The networks, systems and applications that allow intelligence and information to be processed and disseminated are critical to successful ISTAR.

Strategic

The Fylingdales site provides early warning of ballistic missile threats to the UK and is an integral part of the US global early warning network. It also supports UK monitoring of space.

Manned airborne electronic surveillance is currently provided by the Nimrod R1 system. This provides flexible and effective signals intelligence gathering and reconnaissance capability to support operational commanders' campaign plans and to prosecute specific targets. A similar and complementary collection capability is mounted on Royal Navy warships, both surface (COBLU) and sub surface (Eddystone). Land-based systems can also contribute but primarily operate at the tactical level (see below).

A national capability to provide a strategic to tactical level mapping and digital geographic information and imagery derived intelligence to UK forces is pursued under the Picasso programme. This programme is an important component of the UK-US strategic relationship and collaborative intelligence sharing.

For the production and dissemination of military intelligence required for strategic assessment, policy-making, strategic and operational level campaign planning, and as a key input to targeting planning, the UK contributes to and exploits a US classified intelligence database.

Operational

As well as a mix of Type 93 and 101 air defence ground based radars in the UK, a deployable surveillance of airspace capability is provided by the Sentry E3D Airborne Early Warning and Control system. This has the ability to co-ordinate UK and coalition air operations and to direct forces during operations.

The Sea King Mk 7 Airborne Surveillance and Control (SKASaC) helicopter system can operate off naval platforms or the land and provides air and surface surveillance using a mix of electronic, radar and electro-optic sensors.

Long range ground surveillance is provided by the Raptor reconnaissance pod system for Tornado GR4. It provides a medium level, high resolution, long stand-off capability using electro-optical and infra-red sensors with the ability to display images in the cockpit and to transmit these in near real time via a data-link to a ground station for analysis.

Tactical

For land forces electronic surveillance is provided by the Scarus man-portable system and the vehicle mounted INCE and Odette systems. Radar surveillance and target acquisition is provided by the MSTAR man-portable lightweight battlefield radar system.

Limited range full motion video surveillance is provided by the Phoenix tactical Unmanned Air Vehicle (UAV) system. Originally designed for operations in central Europe, it has not proved suitable for supporting ongoing operations in the more demanding climatic and geographical conditions in Iraq and Afghanistan.

ISTAR support to the protection of deployed operating bases in Iraq and Afghanistan is currently met by a mix of visual and electronic surveillance systems often re-deployed from Northern Ireland, supplemented by improved CCTV and lighting.

Urgent Operational Requirements (UORs)

In addition to in-service ISTAR systems, a number of additional capabilities have been provided as Urgent Operational Requirements (UORs) over recent years to address specific capability gaps in current operations in Iraq and Afghanistan. Some of these have delivered improvements to in-service capability; others have involved the bringing forward of capability originally planned for delivery in later years. For the period 2003–07 the emphasis has been on improving the ability to collect ISTAR against an increasingly agile and ISTAR-aware adversary. The main examples of ISTAR UORs are shown below:

Reaper is a long-endurance UAV system providing wide-area all-weather capability in the Afghanistan theatre using electro-optical full motion video and radar sensors. Pre-programmed missions can be flown or the air vehicle can be piloted by datalink.

At the tactical level, accurate, timely and high-quality electro-optical and infra-red imagery is provided in both theatres under a service provision contract with Thales UK using the Hermes 450 UAV system.

The Desert Hawk mini-UAV short range, short endurance system provides a similar capability in direct support to deployed sub units.

Remote video mobile ground terminals allow ISTAR data to be fed directly to deployed ground forces in theatre. The Remote Optical Video Enhanced Receiver (ROVER) III system provides a man-portable feed from a range of UK and coalition full motion video collection platforms to support tactical deployments and operations. It provides deployed ground forces with the ability to improve their situational awareness and force protection.

To improve the current deployed operating base protection capability, new systems have been provided in Iraq and Afghanistan using mast and aerostat-mounted visual and electronic sensors.

Cost of current ISTAR capability

The acquisition costs of the in-service ISTAR equipment covered by this Memorandum are estimated at £1.6 billion. This figure is derived from historical data and includes costs for equipment that in some cases has been in service for a considerable period. The projected cost of supporting the equipment providing current capability is estimated at £970 million over the next 10 years.

Current ISTAR Processes

Conceptually, ISTAR is delivered through two distinct but inter-related capability areas. The collection side aims to provide capabilities that can gather accurate and timely information across the environments and can detect, track, and identify enemy, neutral and friendly entities within a defined area, day and night, and in all weathers. The direction, processing and dissemination side aims to provide capabilities that can direct collection effort and then process and disseminate derived information and intelligence to all levels in national and coalition operations. Currently, considerable effort is needed to draw together the output from collection and analysis systems which tend to focus on specific sources or types of intelligence types and then to disseminate a useful product to users at all levels. Current systems used for this include Joint Operational Command System (JOCS) and other systems dedicated to handling highly classified material.

The output from ISTAR assets is a key input to the planning and execution of operations at all levels and, by improving situational awareness, provides commanders with an increased range of options. The principal users at the strategic level are the Joint Intelligence Committee, the Chiefs of Staff, Defence Intelligence and key allies. At the operational level it is the Chief of Joint Operations and intelligence staff at PJHQ and in deployed higher formation national and coalition HQs. At the tactical level it is brigade and battlegroup commanders and the intelligence staff in brigade and battlegroup (or equivalent) HQs and coalition formations. At all levels, ISTAR output will be exploited by a wide range of capabilities, but this is often as a fused product and not as raw information.

The operational benefits of ISTAR are continually reviewed through a series of formal assessments and informal feedback. Formal ISTAR capability audits are conducted at two yearly intervals as part of MoD capability planning against requirements set out in Defence Strategic Guidance, and are used to inform rebalancing of the Department's Equipment Plan. This complements the detailed operational analysis that supports submission to the approving authorities for each programme and is used to determine the capability to be delivered by DE&S. In addition, feedback is regularly received from operational theatres through visit reports, post-deployment reports and Directorate of Operational Capability audits to inform refinement of forward plans and when necessary to identify requirements for UORs.

The UK has made considerable efforts to co-operate with key allies at the strategic, operational and tactical levels. This delivers significant benefit as, in some scenarios, much of the ISTAR output exploited by UK commanders may have been collected and/or analysed by key allies. Similarly, key allies gain significant benefit from the ISTAR output generated from UK ISTAR collection and/or analytical capability. At the strategic level, UK contributes to a number of collaborative intelligence programmes with key allies that maximise the benefits derived from high value collection and analysis capabilities. This includes the sharing of R&D and the development of common data and technical standards. As improved communications capabilities are delivered, the outputs of collaborative programmes are increasingly being exploited at the operational and tactical levels. Benefit is also derived from participation in a variety of international fora, including:

- *The Interoperability Commission (IOC).* The IOC is the key UK-US senior official level bilateral forum that addresses operational and technical interoperability. Fourteen UK-US "tiger teams" meet regularly to progress interoperability across the whole C4ISTAR (C4 = Command, Control, Communications and Computers) domain;
- *NATO.* NATO has a full sub-committee structure under the NATO C3 Board that covers all aspects of C4ISTAR;
- *Bilateral Meetings.* These include for example meetings with Australia to progress pan-environment military harmonisation;
- *National Armaments Directors (NADs).* The NADs of France, Germany, Italy, UK and the United States) supervise a number of working groups which address C4ISTAR issues including research and technology projects and future UAV operational concepts.

Future ISTAR Capabilty

The current ISTAR programme provides a number of capable collection and analysis capabilities that tend to focus on specific sources or intelligence types and relying on a variety of existing systems and processes to disseminate intelligence and information to all levels. The main issue is that, in general terms, there are sufficient dedicated collection capabilities in service or due to be delivered but that direction, processing and dissemination improvements are needed to exploit current and planned collection capabilities more effectively, to enable more timely satisfaction of critical information requirements and to assist the implementation of NEC. In principle, all ISTAR systems contribute to NEC but the full potential of ISTAR as a capability will not be realised until NEC is mature. The emphasis of current and future ISTAR development is therefore on improving the way the collection of information and intelligence is directed and the resulting data processed and disseminated. This emphasis is reflected in the following discussion of future equipment capability programmes

Future ISTAR capability equipment programmes

The Department has plans to address the recognised shortfalls in the direction, processing and dissemination elements of the intelligence cycle and to improve the persistence, reach and accuracy of dedicated ISTAR collection capabilities. These plans are being closely co-ordinated with the programme to modernise Defence Intelligence operations which is addressing wider improvement in the handling of all forms of intelligence. The main dedicated new ISTAR programmes involved are described below.

DABINETT is an incremental programme that will improve the coherence and networking of ISTAR across Defence to provide actionable information and intelligence at all levels. It is expected to include a combination of existing and future platforms and sensors, support centres and links to intelligence systems. It is about to enter the assessment phase. Delivery is expected to be through a range of separate but coherent projects. The programme has two main objectives: improvements to the direction, processing and dissemination of intelligence and information; and improving deep and persistent collection capability. The latter may be partially met by retaining the Reaper capability acquired to meet operational requirements in Afghanistan.

ASTOR (Airborne Stand-off Radar) addresses requirements for surveillance, reconnaissance & target acquisition information on moving, stationary & fixed targets in the land environment. The system, based on business jet aircraft, provides a joint, near real time, 24hr and all-weather Synthetic Aperture Radar and Moving Target Indicator capability. It is currently due to come into service by the end of 2008.

The UK WATCHKEEPER UAV system will provide UK commanders, primarily at brigade but also at battlegroup level, with accurate, timely and high quality information including imagery, using electro-optical and Synthetic Aperture Radar and Moving Target Indicator sensors. The air vehicle is based on the Hermes 450 but WATCHKEEPER will be fully integrated into the wider command and control network. The capability will begin to be delivered from the end of the decade.

Project EAGLE aims to sustain and upgrade the UK Airborne Early Warning capability provided by the Sentry E-3D. It will enable Sentry E3D to perform more effectively as an Airborne Early Warning and Control (AWACS) platform, managing the air battle across the range of operations with maximum interoperability with NATO allies. The project is currently in the assessment phase.

HELIX aims to sustain and upgrade the UK's dedicated airborne electronic surveillance capability against an evolving and increasingly complex target set out to 2025, replacing the capability currently provided by the NIMROD R1. The programme is currently in the assessment phase.

SOOTHSAYER is an integrated vehicle-mounted Land Electronic Warfare (EW) System in the demonstration and manufacture stage. It replaces and enhances the Odette and Ince systems and will begin to enter service towards the end of the decade. SHAMAN is a broadly equivalent system for naval platforms and is currently in the assessment phase.

URBAN and REAR ISTAR aims to provide a coherent and integrated urban and rear area ISTAR surveillance capability through the networking of ISTAR sensors and platforms to enable the Land commander to conduct ISTAR within these complex environments. It will also improve protection of deployed operating bases, releasing key manpower from surveillance tasks and enhancing force protection. It is currently at the early concept stage.

Priorities

DABINETT is the highest priority ISTAR programme because of the improvements it will bring to the way information and intelligence is directed, processed and disseminated, thereby improving the coherent exploitation of the increasingly capable collection assets and enabling NEC. Success is closely related to maintaining coherence with other programmes particularly those which support the programme to modernise Defence Intelligence operations such as Defence Information Infrastructure (DII) (particularly the above-secret elements of the programme), Picasso and the Joint Command and Control System Programme (JC2SP).

Other priorities include upgrading the UK air defence ground based radar system, sustaining the electronic warfare database, electronic and wide area surveillance, how to meet the demands of time sensitive targeting and the implementation of robust procedures to exploit the new UAV capabilities. We also need to remain interoperable with the US while improving interoperability with other allies and ensure that we coordinate with other Government departments that have an interest in ISTAR capability, for example GCHQ.

Role of UAVs

ISTAR collection requirements in Iraq and Afghanistan are being delivered through a layered approach using manned and unmanned platforms. This is seen as the model for the future. The manned capabilities (provided on current operations by for example the Nimrod R1, Nimrod MR2 and surveillance helicopters) provide variously point target, strategic and tactical ISTAR. The long loiter, deep and persistent requirement for ISTAR is increasingly being met through UAVs equipped with Full Motion Video (FMV) and in some cases radar and other sensors operating in three layers. These can be illustrated for the land environment as follows:

— *Theatre/Operational Level.* At this level there is a requirement for long range, long loiter systems to provide ISTAR in real time in order to assist decision making, improve situational awareness and support targeting. They can fulfil roles such as border surveillance. At this level, support to deployed formations is likely to be indirect in nature. The need to provide control over a large geographic area and provide product to dispersed locations, including strategic feed back to UK, means that such systems require a beyond line of sight communications capability. On current operations, the Reaper UAV system acquired under UOR arrangements is providing capability.

— *Formation/Higher Tactical Level.* At this level the requirement is for a UAV capability controlled by and in direct support of brigade level operations. Typical tasks include: pattern of life monitoring prior to specific operations; find/track surveillance of tactical high priority targets; provision of guaranteed continuous coverage of operations; force protection to convoys; and Improvised Explosive Device (IED) searches along supply routes. On current operations, the capability is provided as service by Thales UK using the Hermes 450 UAV system under UOR arrangements. WATCHKEEPER will fulfil a similar role.

— *Lower Tactical Level.* At this level, company and battlegroup level units require the ability to deploy rapidly a locally controlled ISTAR system to gain situational awareness relevant to an immediate localised threat or individual engagement. The very rapid response required, as well as the short range of these operations, means that a UAV, controlled at the lowest level in direct support of troops in contact is typically best suited to meet the requirement. On current operations the Desert Hawk min-UAV system acquired under UOR arrangements is providing capability.

The layered approach ensures that products that support decision making, situational awareness and targeting are provided directly to each level within the chain of command. This also allows sensible investment and the achievement of value for money by matching capability to requirement. While the varied needs of each level of command could be met by a single platform type, the capability would need to be driven by the most demanding requirement (long range, long persistence, very capable sensors). This could lead to disproportionate cost, delayed timelines and, at lower levels, excessive capability.

19 February 2008

Memorandum from BAE Systems

1. Summary

1.1 Our support to current operations has shown how Autonomous Systems can transform military and security operations by providing discriminating capabilities more cost effectively than current Unmanned Air Vehicle (UAV) solutions or other manned solutions to surveillance, tracking and reconnaissance problems. As a result the company continues to invest in the UK to develop leading edge Unmanned Aerial Systems (UAS) that demonstrate increasing levels of autonomous behaviour.

1.2 The distinction between remotely-piloted UAVs and UASs is more than semantic. Whereas most previous and current generation UAVs only displaced the air vehicle pilot and payload commander to a remote location, the crew remain an intrinsic part of the solution. As a result, UAVs are often just as labour intensive as their manned counterparts and have operating costs to match. Viewed in the context of missions that may exceed 24 hours duration this represents a significant handicap.

1.3 The UAS meanwhile is specifically designed to address these limitations. It comprises the air-vehicle, sensor suite and control infrastructure that has the ability to analyse and disseminate the resultant intelligence products in a timely manner across the operational space. BAE Systems has developed autonomous systems encompassing all these elements that are capable of managing mission tasks without

direct operator interaction. For example, the company's High Endurance Rapid Technology Insertion (HERTI) UAS can be commanded to proceed to a pre-defined search area, complete a search using wide field of view sensors to cue narrow field of view sensors, then report back to the mission commander the intelligence products gathered—all without human intervention—including take-off and landing. The system will intelligently complete the task even if there is no direct communication with the mission commander. This significantly reduces the mission commander's workload whilst minimising the deployed operational footprint of the system and reducing its whole life costs. Through its investments, BAE Systems has developed world-leading autonomous systems capability and has, in partnership with the MoD Air Warfare Centre Unmanned Aerial Systems Battle Labs (AWC-AUB), deployed the capability into a live operational theatre.

1.4 From these deployments, known as "Project Morrigan", it is clear that the use of UASs as part of the frontline provides considerable advantage. In particular, they offer the ability to remain on station for protracted periods of time over "points-of-interest" whilst simultaneously providing high quality real time intelligence. The combination of persistence and quality intelligence coupled with appropriate dissemination to local and/or remote headquarters provides the opportunity to react to rapidly evolving situations within very short time periods compared to more traditional systems. The lessons learned from Project Morrigan demonstrated that working together with the MoD and operational community enabled rapid evolution of the system capability and showed a potential route to more cost-effective and timely procurement. Furthermore, the use of autonomy highlighted tangible opportunities to reduce the deployed footprint and to ease the burden placed on operators/analysts at each level throughout the intelligence exploitation chain; thus further contributing to reducing the overall cost of ownership.

1.5 We staunchly support the MoD's Defence Technology Strategy[1] and believe that there is a national imperative for the UK to develop and retain its world-class sovereign autonomous systems engineering skills and system design capability. A vibrant UAS capability provides the critical mass to deliver the actionable intelligence for a responsive and flexible war fighting force. A successful and sustainable defence component will, in turn, be an enabler of national security and the freedom to independently act. It is predicted that autonomy will be the way of the future for generations to come. The question for the UK is therefore whether it wishes to nurture a national capability to meet its long-term needs or whether to be beholden on generations of off-shore supply.

1.6 Autonomy has the potential to have a far reaching impact across defence and the wider economy. We therefore urge the Defence Committee to encourage MoD to develop a strategy to ensure that:

- The UK's ability to provide world-class autonomous Unmanned Aerial Systems is nurtured and deployed to provide military effect to the front line.
- UAS investment across DE&S Integrated Project Teams (IPTs), the Research Acquisition Organisation (RAO) and Directors of Equipment Capability (DECs) is channelled to ensure that programmes provide flexibility in the provision of frontline capability at a pace consistent with the rapidly evolving needs in theatre.
- A synchronised approach be taken to public and private research funding that is jointly reviewed and challenged to ensure that research outcomes generate greater UK capabilities and sovereign competitiveness within the global market.
- Funding to solve Urgent Operational Requirements is carefully managed to ensure this is not to the detriment of long-term capability development.

2. The Contribution UAVs are Making to the MoD's Current ISTAR Capability

2.1 BAE Systems continues to focus its internal investment on end-to-end ISTAR/UAS research, development and manufacture. This provides a catalyst for the MoD to rapidly define and deploy state-of-the-art systems to the front line. In particular the company has supported the MoD with UAS system operations, intelligence gathering and intelligence dissemination.

2.1.1 Through a partnership with the MoD Air Warfare Centre Unmanned Aerial Systems Battle Labs (AWC-AUB), BAE Systems supported the deployment of a HERTI UAS for a three month deployment into Afghanistan. The deployment was achieved within 6 months of the declaration of intent by the MoD and included training the RAF team to operate the HERTI System without in-country contractor support. Whilst in theatre the system provided significant contributions to intelligence, surveillance and strategic reconnaissance missions. The deployment met the objectives set by the AWC-AUB and was quoted as providing a "genuine capability to affect operations on the ground, save lives, and contribute towards stabilisation and regeneration in South Afghanistan".

2.1.2 Information/Intelligence collected from current UAVs is predominantly used to support deployed forces to conduct operations within an opponent's reaction timelines. To do this effectively it is necessary to compress the collection and dissemination cycle time as much as possible in order to deliver, actionable, timely intelligence to the commander in the field. However, a current limitation is a lack of effective connectivity between theatre assets and those within the MoD and National Intelligence communities. Our investment in intelligence gathering and dissemination is therefore focused in two principle areas; autonomous sensor management and the management of the resultant information into actionable

intelligence through analysis and correlation with national and other intelligence sources. With respect to autonomous sensor management and its impact on intelligence gathering, Project Morrigan proved the benefits of autonomous systems in reducing analyst workload whilst speeding up the ability to collect against specified target sets. The company is now focused on how to progress autonomous cueing of multi-Intelligence sensors within a UAS sensor package—for example using an Electronic Surveillance Measurement sensor to autonomously cue an imaging sensor thus improving the fidelity of the information provided to the analytical teams. With respect to the key issue of Information Management, BAE Systems has demonstrated incremental capability to manage information and the resultant intelligence between theatre and national intelligence capabilities through demonstration at Coalition Warfare Interoperability Demonstrations (CWID) during 2005, 2006 and 2007. This capability was further demonstrated during Project Morrigan when imagery collected in theatre was made available to analysts at Joint Air Reconnaissance Intelligence Centre (JARIC), the national imagery centre of excellence, in a timely manner. BAE Systems is also investing in security and information assurance capabilities which will enable electronic connectivity between the Top Secret and Secret domains and with our key coalition partners (particularly the US). This will further enhance the ability to disseminate and share intelligence in a timely manner.

2.2 The lessons learnt from Project Morrigan have led to the following conclusions:

— Integrating system autonomy with the concepts of employment provides new innovative mechanisms to achieve the tasking orders.

— Autonomous systems provide significant reductions in the time required to process and analyse data ensuring the time to observe, orientate, decide and act lie well within the opposition's reaction time.

— Autonomous UAS operations significantly reduce the in-theatre manpower requirements and provide reduced operator workload in mission preparation, execution, recovery and debrief.

— UAS can be integrated into the manned war fighting environment in a coherent way significantly improving its contribution.

3. Training and Impact on Airspace Management

3.1 The ability to integrate and synchronise ground and air elements of the end-to-end command chain is fundamental to the delivery of effective operations. It is therefore imperative for fighting forces to train as they will be expected to operate in theatre. However, the freedom to operate UASs within general airspace is a limiting factor that must be addressed if the UK is to be able to capitalise on its UAS inventory. It therefore follows, that safe operations of UASs within partially and/or non-segregated airspace is a fundamental enabler to achieving flexible and cost effective training of personnel.

3.2 Today, UAS operations are limited due to their airworthiness certification restrictions. Two critical actions are therefore required:

— To achieve regulatory and public acceptance for UAS operations within the UK.

— To provide a catalyst for investment into opening the airspace for state and civil operations.

3.3 In support of these particular needs and to open the airspace for security and civil operations, BAE Systems used company funding to demonstrate safe UAS operations over the UK. In March 2003, the company's Kestrel UAV became the first CAA registered vehicle to fly in UK airspace. This represented a key milestone in proving the design and airworthiness processes. This was followed in August 2006, when the HERTI UAS recorded the first UK autonomous UAS flight of a CAA registered system.

3.4 Building upon the National Aerospace Technology Strategy (NATS), BAE Systems formed the £32M UK ASTRAEA programme along with its fellow funding partners (Department of Trade and Industry (now DBERR), Welsh Development Agency (now WAG), North West Regional Development Agency, South East England Development Agency, South West England Regional Development Agency, Scottish Enterprise, EADS UK, Rolls-Royce, Thales, QinetiQ, Flight Refuelling and Agent Orientated Software. MoD supports ASTRAEA in an observer role and is being encouraged to become a full partner as a significant gearing to all parties could be achieved if knowledge and investment from the MoD were to be included. ASTRAEA investment is focussed on technology development, regulatory understanding and system demonstrations to achieve the goal of achieving the routine, non-segregated operation of UAVs in UK's airspace. From the success to date, further investment is being considered that would take the non-military investment to a total of £64M; of which Industry will have contributed £32M.

4. Incorporation of the Lesson Learnt for Current Operations in Current Development Programmes

4.1 BAE Systems has acquired significant experiences from its AWC-AUB partnership, the latter's support of our engineering trials and feedback provided from the AWC-AUB during and post the Afghanistan deployment of its HERTI UAS. The lessons learnt have provided many system improvements and several, in-theatre, operational up-dates that instantly improved system effectiveness. The net effect of this relationship has provided advancement in the maturity and effectiveness of the HERTI UAS within

weeks rather than the traditional years normally taken for more traditional procurement programmes. Equally, this joint activity has provided a much deeper understanding of the concepts of employment of autonomous systems in achieving mission effectiveness, including those issues relating to airspace management and the legality of systems.

5. Research and Development

5.1 One of the critical areas for investment is Systems Autonomy and excellence in Systems Engineering. The BAE Systems led consortium under the Systems Engineering and Autonomous Systems Defence Technology Centre (SEAS DTC) provides core research in the field of system autonomy across the land, sea and air domains. This MoD initiative competitively won by the BAE Systems consortium, is jointly funded providing an equivalent investment of £10M per annum into core technology. The SEAS DTC, now in its third year, has already demonstrated technology and innovation that supports a wide range of future developments. Agreement to extend the SEAS DTC for a further three years has already been reached with MoD.

6. The Defence Sector's Contribution to the UK [2]

6.1 The DIUS R&D scoreboard showed that UK companies channelled £2.4Bn in aerospace and defence research in 2006, making the sector the UK's second largest by R&D spend. 10 UK engineering companies rank in the top 100 largest global defence businesses.

6.2 In the period 2002 to 2006 the UK secured defence exports valued at £41Bn and over 300,000 UK jobs are dependent on UK defence spending.

6.3 As the UK's largest defence company and employer of UK's greatest concentration of qualified engineers we believe that there is a direct correlation between the vitality of the UK defence sector, the UK's engineering capability and the security and prosperity of the Nation. The UK Defence Industry is the world's second largest and is founded upon a world-class engineering capability. The industry sustains investment in research and technology, people and engineering processes that benefit not only its own purposes but also, through academic partnerships and its supply chain, the broader UK engineering sector.

6.4 We recognise that the Committee's Inquiry is not centred on the wider industrial contribution to frontline effectiveness. However, we would encourage the Committee to identify and recognise those key industries that are proactively creating world class capability and critical mass in the field of autonomous UASs and Unmanned Combat Aerial Vehicles (UCAVs).

Attributed Information Sources

(1) Defence Technology Strategy—for the demands of the 21st century.

(2) Study of BAE Systems Economic Impact to the UK Economy—conducted by Oxford Economic Forecasting and Geo Economics (Due for publication—April 2008).

14 April 2008

Memorandum from the Royal Aeronautical Society

Introduction

1. The Royal Aeronautical Society (RAeS) is the Learned Society for the Aerospace and Aviation community. Based in London, it has a worldwide membership of over 19,000, with over 13,000 in the UK. Its Fellows and Members represent all levels of the aeronautical community both active and retired with around a half of these as professional engineers. In addition, the Society has over 120 organisations that are members of its Corporate Partners scheme. It has Airpower and UAV Specialist Groups, with members drawn from industry, academia and the services.

Background

2. The term UAV (Unmanned Aerial Vehicle) is now being replaced by both North American and European authorities by the term Unmanned Aircraft (UA) System (UAS) for two main reasons: If UAVs are to file and fly alongside manned aviation in non-segregated airspace, they must be equivalent to and regarded as aircraft; the key feature of a UAS is the 'system', which may comprise several UAVs, control stations and launch and recovery elements.

3. The UAV is not a new concept and early UAV work dates from the pioneering days of powered flight. The US Military used target drones fitted with cameras for aerial surveillance during the Viet Nam conflict. Israel pioneered the development and military use of a new generation of UAVs, but it was the US that rapidly adopted the technology and is now investing heavily in advanced platforms and associated payload technologies. The US armed forces have accumulated considerable operational experience and have deployed armed UAVs in Iraq and Afghanistan. The US alone intends to invest over $2 billion in UAS research and procurement over the next five years.

4. Currently over 39 countries have developed or are developing UAVs of varying sizes and with varying levels of technical sophistication. A 2005 census revealed some 400 UAV programmes in existence or under development.

UK Experience with Unmanned Aircraft Systems

5. The UK experience with UAV technology has not been entirely happy, pace the Phoenix programme. However, procurement of the Watchkeeper for tactical surveillance missions and the UOR-procured US Reaper armed ISTAR asset, marked an important shift in the priority attached to unmanned platforms. Further training and operational experience in UAS operation has been obtained in cooperation with the US. UK forces are flying Predator over Afghanistan (and possibly also Iraq) with RAF pilots based at Nellis Air Force Base near Las Vegas. According to anecdotal evidence, this has been highly successful, and through very close integration with the US operators there, a great deal has been learned. UK Forces on the ground have been using the Lockheed Martin Desert Hawk to excellent effect for short range ISTAR. For local commanders, it is extremely useful to have an integral asset giving an "over the horizon" view and again, anecdotal evidence suggests that UK forces have learned much from the experience. The BAE SYSTEMS Herti UAV has also been deployed operationally in Afghanistan.

6. In the longer term, industry-government support for projects such as the Taranis UCAS demonstrator will facilitate UK national technology acquisition in advanced unmanned combat platforms, with advanced propulsion systems and increased capacity for autonomous operation.

7. In general, the MoD and the UK armed services were perhaps slow to appreciate the potential of unmanned systems and the value of UAS operations is still only beginning to be recognised in MoD and only in specialised areas. However, it is evident from the Afghanistan deployment and commitment of research funds to technology acquisition in this area that the general awareness of UAS is very much better than before and improving at a pace. The Society believes that ISTAR is one of the specialised areas where UASs are being taken seriously and that MoD ISTAR planning has been and is being further reassessed as a result of UAS experience.

UAS and ISTAR

8. The advantages of the UA for any mission can be summarised under the rubric "dull, dirty and dangerous". The use of unmanned platforms for ISTAR missions would certainly conform to the "dull" specification and, in many circumstances, would be classed as "dangerous". Use in contaminated conflict environments (such as those caused by chemical or nuclear weapons) is considered "dirty".

Persistence

9. The particular benefit of a UA approach to ISTAR is the persistence offered by long endurance vehicles. Endurance can now be measured in days rather than hours. An Israeli UAS will be deployed later this year in a maritime surveillance role capable of 50-hour autonomous missions. A comparable manned patrol aircraft would have a six to eight hour endurance, with higher operational and maintenance costs.

10. The persistence characteristic applies equally to the "piloting" functions as well as the "observer" function. Personnel can be rotated during the course of a mission reducing the effects of fatigue on real-time observation and analysis. Equally valuable, a "second opinion" can be sought to verify targets and to take offensive action if required.

Vulnerability

11. UAs are also largely invisible and inaudible from the ground, which when combined with persistence makes them a formidable capability especially over difficult and hostile terrain. However, should the platform be located, it is potentially more vulnerable to counter measures as reaction to ground fire may be slower, and the system intrinsically less able to evade hostile action.

Cost

12. Although the smaller UAs do offer savings in terms of operational and maintenance costs, they should not be seen as a cheap option, nor are they necessarily expendable in anything other than human terms. This may be more valid for the smaller tactical UA platforms currently deployed by US forces in tactical, platoon level operations, but not in the case of the more sophisticated platforms such as Reaper. The larger more sophisticated UASs are costly to acquire and also need an extensive support and operational team both within the theatre of operations and at the centre of operations. Although the requirement for trained pilots to 'fly' UA platforms such as Predator and Reaper, it is a sensible and pragmatic way forward now.

Autonomy

13. Much is being learned from operation by the much more autonomous Global Hawk by US forces and by German and Australian forces through their assessment of it. More autonomous systems may reduce the operational costs of UAS operation. It will also reduce the bandwidth communication requirements that under intense battlefield conditions can cause problems for other users and applications. However, autonomous operation with armed UA vehicles raises questions about rules of engagement. It is likely that weapons release will still require human intervention.

Reliability issues

14. UA vehicles, while undoubtedly more reliable than even five years ago, are also more prone to failure and to pilot error (exacerbated by the difficulties of responding quickly to flying conditions and landing the vehicle under problematic weather conditions). Weather may generally set lower levels of availability, with tighter restrictions on landing and take-off conditions.

Performance considerations and new roles and applications

15. Since a UA does not have a human pilot (nor—at present—human payloads) their performance need not be constrained by human health and safety considerations. In addition to persistence, a UA can climb, dive and turn faster and more tightly than manned aircraft ("pull more G force"), giving them superior aerobatic capabilities. This has led the US Air Force to call for Unmanned Combat Aircraft Systems (UCAS), which are confidently predicted to outperform future manned combat aircraft in the next decade or two. Such UCAS will also deliver ISTAR capabilities. Several European countries, including the UK, are pursuing the early stages of UCAS programmes.

The nature of UAS and compatibility with Network Enabled Capability (NEC)

16. As the level of automation increases in UAS, there is an ever-increasing dependence on information and communications technology (ICT). Smaller, more powerful computing infrastructure with lower power requirements, rapidly evolving automation software, and robust and secure telecommunication bandwidth are enabling ever greater operational capabilities for UAS. Increasing software sophistication and its widespread replication not only give economies of scale (as with many ICT systems) but also reduce the training burden on operators. Robust, mature and certified software delivers predictable responses under a wide range of conditions.

17. The system nature of a UAS, heavily based on ICT, can be designed to be highly compatible with NEC. The UA and the UAS can be regarded as (ISTAR) nodes in the NEC Network. Systems designed to comply with emerging NEC standards will enhance interoperability and synergy. For this to be possible, the management of UAS ISTAR requirements has to take a range of different functional views from project level up to enterprise level, which is entirely consistent and compatible with the procurement approach recommended for all NEC-related projects and programmes.

UAS-ISTAR as a "purple" asset

18. One of the main objectives of NEC is the provision of a relevant, common operational picture (COP) to every Defence user. For this to be possible, several requirements exist; including sensor systems conforming to NEC interface standards, a suitable infrastructure and dynamic rule set to construct the numerous relevant COPs and the ability to distribute them to the respective users. This is not unique to UAS—all ISTAR assets face the same challenges. The most important thing is for ISTAR projects, including UAS, to be designed to meet the enterprise-level requirements of NEC.

19. Inter-service rivalry in the development and deployment of UAS-ISTAR assets is a persistent issue, certainly for the US military. However, while the current UK experience appears to be somewhat better the Phoenix was a Royal Artillery (RA) -sponsored project and was seen as a RA Reconnaissance and Target Acquisition system (possibly also with battle damage assessment (BDA) capability. Any suggestion that it

might be used for surveillance and intelligence purposes was fiercely contested. In summary, the other challenge is a cultural and organisational need to take an enterprise level view of capability management. It is vital that the UK should continue to develop a cross-service approach to this asset, particularly for the wider battlespace and strategic perspective. Currently, the Reaper is operated by the RAF, while Watchkeeper will be deployed by the Army. While there is no reason to suppose that use of these assets and the data they obtain will not be well coordinated, the MoD should ensure that all UAV assets are developed and deployed according to an overall strategy for UAV-related activities.

Cooperation between allies

20. There is good cooperation at many levels internationally and in the unmanned systems community generally, there is good sharing of common operational experience (although the Israelis seem guarded about some aspects). Bilateral, multilateral, NATO and EDA groups all share their experience, and the US-UK relationship has been particularly fruitful. International professional organisations make a point of encouraging the sharing of experience at conferences and workshops. The Royal Aeronautical Society is part of this community and provides a context and a forum for the discussion of evolving UAS technology and operations.

Integration into controlled airspace

21. The US and European militaries, as well as potential civil operators, have an urgent requirement to access controlled non-segregated airspace. This is essential for transit from continental bases to fulfil time-sensitive mission needs, as well as for training activities. This has been defined as the "file and fly" requirement to operate UAS vehicles alongside conventional manned aviation without the need for special clearance and flight-control protocols. At a minimum, UAs will need to be provided the capability for routine separation assurance and integration into Air Traffic Management (ATM) procedures but will also need an effective and reliable "sense and avoid system" for last minute collision avoidance, These capabilities may be both onboard the UA and as part of the mission control system.

22. In many cases, UA operation in the US still requires a Special Military Operations order to fly a UAS in controlled airspace. This can take up to two months to implement. However, in 2003, the Air Force received a national certificate of authorization (COA) allowing Global Hawk UAVs to fly in unrestricted airspace. Flights still require five days' notice to the Federal Aviation Authority, however.

23. Work is continuing in both the US and Europe to establish protocols for operating UASs in controlled non-segregated airspace, and the necessary technical solutions and regulatory changes are expected to emerge within the next five years. In Europe, several national aviation authorities, including the UK CAA, are working with EASA and EUROCONTROL to coordinate the necessary work. The CAA is about to release the second version of CAP722, the document that deals with the operation of both civilian and military UASs lighter than 150kg in UK airspace. European groups are basing their approach to UA lighter than 150kg on the UK CAA CAP722, which is regarded as a leading source of guidance.

24. For the Military, EUROCONTROL, NATO and EDA are developing management papers. On the civilian side, the European Organisation for Civil Aviation Equipment (EUROCAE) established Working Group 73 in April 2006 to develop the necessary standards for consideration by the authorities. WG73 work is progressing in coordination with both Military and other international organisations. It is predicted that there will be a strong growth in civil applications of "light UAS" (ie those under 150kg) under national arrangements in advance of definitive EASA and EUROCONROL regulations for UA of more than 150kg. This reflects the extensive use by deployed UK forces of the light 'Desert Hawk' UAS for close range ISTAR.

Training and testing issues

25. There are European test ranges (for example, NEAT in Sweden and another above the Arctic circle in Finland) where UA operation has little impact on civilian air traffic. However, for much of Europe it is difficult to find suitable airspace for training purposes. There is limited but still useful segregated airspace at Parc Aberporth in Wales, which is already being used by some UA companies. Extension to the Parc Aberporth segregated airspace is currently under consideration. This would be greatly welcomed by the UK UAS community

26. Once the EASA and EUROCONTROL regulations are in place, training with certified UA will be easier. However, UA R&D will still require segregated airspace and this will need to be found anywhere that is accessible, practical and affordable. If UK/Europe wishes to compete in the global UAS market place this will have to be made available as a matter of urgency.

INDUSTRIAL ISSUES

27. The importance of UAS technology is well noted in the Defence Technology Strategy (DTS) and also reflected in subsequent R&D investment by the MoD and Industry. The Society also appreciates the need to address Urgent Operational Requirements as in the Reaper acquisition. However, there are two consequences of reverting to a US solution by default. First, it cannot be assumed that technology will be shared from participation in future US programmes nor is it likely that it will come from commercial aerospace developments. Secondly, a typical UAV reconnaissance payload for both military and civil applications might consist of a miniaturized Synthetic Aperture radar slaved autonomously to an Electro-optic sensor. These are both technologies that were identified in DIS 1 as being ones over which the UK needed to maintain operational sovereignty. However, by resorting to a US solution by default, there is no incentive for industry to invest PV funding in these key technologies and maintain the capability in the UK. The related technology trajectory will thus be fractured. The same is true in propulsion where design of advanced stealthy UAS platforms will be dictated by the engine, and where the needs of electrical power generation and heat dissipation management is leading to consideration of an Integrated Power System, provided by a single supplier.

28. In the longer term, military UAVs will need to be capable of 'swarming' such that clusters of them can undertake complex tasks (both attack and reconnaissance) in dangerous circumstances on day one of the war. This capability, which is already within the grasp of US UCAVs, is unlikely to be exported in any transparent way that allows operational sovereignty to be exercised by the UK on these classes of platforms. As a result, the UK MoD will need to fund the necessary research to create an on-shore capability in mission system design. In addition, airframe-engine combinations will probably reach their design limit ahead of that of systems, sensors and software which have the potential (as in the fixed-wing fast jet case) continually to evolve and thus provide affordable, incremental capability upgrade. Again, this needs to be an area of investment for the UK MoD.

29. Overall, the arrival of the UAS is also effecting a change to the industrial landscape. New suppliers at all levels of the supply chain are being drawn into the market to provide novel technical and cost-effective solutions. This trend was to some extent noted in the Defence Industry Strategy; but the MoD should continue to monitor these developments and to make the necessary adjustments in acquisition and industry strategy in order to encourage the evolution of an effective UK based UAS capability.

17 April 2008

Memorandum from Lee Bruce and Dr Robert Crowcroft

This is a submission from Mr Lee Bruce and Dr Robert Crowcroft. Mr Bruce is an expert on counter-insurgency strategy and defence having completed a research thesis in History at the University of Leeds on British military and political policy in Northern Ireland. Dr Crowcroft is an expert on British political parties, defence and international affairs. He recently received a doctorate in History from the University of Leeds on British politics and statesmanship during the Second World War. He has published articles in learned journals.

SUMMARY

— Government expenditure should be focused principally upon human intelligence rather than technological platforms. Unmanned Aerial Vehicles (UAVs) are important in target acquisition and shaping both battlefield and intelligence environment. However, it is crucial to recast thinking about Governmental expenditure toward a more coherent policy for properly exploiting the existing superiority of our armed forces in the combat environments within which they presently function.

— UAVs cannot provide information about the mindset, attitudes and assumptions of the enemy or the dynamics of their organisational structure. This poses serious issues about the penetration of actors' intentions rather than their capabilities, and should have ramifications for expenditure on ISTAR.

— Nevertheless, UAVs remain a valuable instrument for UK armed services. Yet their proper exploitation necessitates much greater commensurate investment in the weapons platforms—specifically attack aircraft and missile systems—required to act promptly on the information that UAVs garner. Insufficient aircraft and weapons pose the risk that valuable intelligence cannot be acted upon swiftly.

— Given the ever-increasing pressures on the defence budget, difficult choices must be made. It is absurd that the War on Terror continues to be fought without reliable human intelligence capabilities at the disposal of our armed forces. Before Government devotes resources to capital intensive platforms, it should guarantee that basic human intelligence structures are embedded within the UK armed services.

— At a time of heightening international instability the failure to articulate what UK armed services are intended to achieve signifies serious neglect. This is evidenced by the recent conflation of climate change and globalisation as challenges comparable to Islamic terrorism as a threat to the security of the British state.

How the information/intelligence collected from current UAVs is used and what factors are limiting the most effective use of this information/intelligence

UAVs are employed for a range of target acquisition and battlefield intelligence operations. To utilise them to their proper potential now demands that the armed services be granted more robust Rules of Engagement which permit them to engage and destroy enemy positions less handicapped by political obsession with "collateral" damage. Such concern is arguably a product of public and Westminster perception that warfare is inherently about peacekeeping, and contrasts starkly with the Clausewitzian mantra that "Given the same amount of intelligence, timidity will do a thousand times more damage than audacity".

Unless the Government invests substantially more resources in aerial weaponry, particularly military strike aircraft and missile systems, the UK will be unable to properly utilise UAV capabilities. Lacking sufficient airpower to engage and destroy enemy forces immediately upon their location, the value of this knowledge, and by extension the value of the expenditure on the UAVs, is limited. An example of the successful utilisation of UAVs operating in tandem with airpower was the June 2006 acquisition of the location of Al-Qaeda in Iraq commander Abu Musab al-Zarqawi and his prompt liquidation by US warplanes. At present so much information gleaned by the UAVs could be rendered worthless by the lack of sufficient aerial assets to exploit the intelligence in a timely fashion. The seriousness of this deficiency would be greatly magnified if the UK became embroiled in conflict with a technologically sophisticated enemy capable of forward engagement with UK or allied forces. The danger is that low-intensity operations mask British vulnerabilities.

At a time of increasing threat from a multitude of global challenges including the growth of renewed Russian bellicosity and Islamic terrorism, it is disconcerting that the Government is cutting the defence budget in real terms. No manipulation of fiscal rules or "spin" can obscure how poorly funded the UK's armed services have remained since the end of the Cold War. It is absolutely vital that leadership be demonstrated by investing heavily in both ISTAR and a plurality of weapons capabilities.

Whether the MoD is exploiting fully the ISTAR capabilities offered by UAVs (including drawing on the experience of its allies)

As outlined above, the UK is incapable fully utilising its ISTAR capability due to a lack of investment in military assets. Such funding is unlikely to be forthcoming under present circumstances due to both the failure to express a coherent concept of what UK defence policy is intended to achieve and the Government's political priorities. On the other hand, a determined and robust application of an interoperable armed service has led to significant breakthroughs in Iraq by US forces.

How the current and future ISTAR capabilities offered by UAVs is informing the MoD's overall approach/direction relating to ISTAR

While the importance of UAVs is clear from the information above, nonetheless it is critical to rebalance ISTAR expenditure and planning to produce more effective human outcomes on the battlefield. The most basic concern of ISTAR planning should reside with the cultivation and development of human intelligence resources. This should necessitate a dramatic increase in both Arabic and Pashtun speakers embedded within the armed forces, thus reducing the UK's current dependency on employing indigenous individuals as linguistic experts. The loyalty of such people can be bought and sold; basing a key part of UK operational planning during sustained and medium-scale wars upon non-UK, non-armed forces personnel is illogical. Given the high probability that the current state of affairs will persist for several decades, the continuing failure to properly integrate trained linguistic experts within the armed forces units conducting counter-insurgency operations represents a fundamental failure in ISTAR planning.

The UK military must be restructured to enable the embedding of Arabic and Pashtun experts within armed forces on the front line. In particular, the UK should build-up a large and indigenous reservoir of personnel with such skills as a matter of urgency. It is difficult to conceive how counter-insurgency and ISTAR operations can be effectively conducted without direct and reliable communication between UK armed forces and locals in which British personnel control the flow of information and conversation.

Often it is asserted that the UK has an exemplary record in counter-insurgency operations, the evidence for which is the success of conflict resolution in Northern Ireland. Yet one lesson from this conflict that is presently being ignored was the interaction between the army, MI5 and the local communities of both ethnic divides. The real reason for success was the capacity of the intelligence services to infiltrate and manipulate insurgent groups. If the UK is to reverse the trend of failure that it is currently experiencing, especially in Basra, the military must re-engage with the local populace. But this can only be done if the armed forces are

properly structured for the task of communication. Again, this is not an impossible goal as the shift in strategic direction conducted by US General David Peatreus continues to demonstrate real gains. Human intelligence appears the most potent, effective and, in fact, in financial terms probably the cheapest, form of intelligence gathering. The benefits accruing from it should not be arbitrarily dismissed.

Conclusion

Successful utilisation of UAV capabilities is crucial. But the UK government should be concerned with a commensurate expansion of the capabilities necessary to exploit it, namely aircraft and aerial weapons platforms. Simultaneously, it is a matter of concern that perhaps too great an emphasis is being placed upon technological solutions and the basic ISTAR capabilities—most seriously linguistic experts within the military—continue to be overlooked. Whilst UAV technology can illuminate an adversary's location and capability it conveys little to UK armed forces about intentions and broader strategic concerns. Both the technological and human intelligence aspects to ISTAR must receive greater emphasis; but it seems self-evident to get the basics right first.

In failing to provide clear doctrinal guidance upon which defence acquisitions can be made, the Government continues to articulate an incoherent defence vision. This makes it a near impossible task to judge the success or otherwise of defence expenditure. The basic duty of the state is to protect the lives of its citizenry. Given the gravity of the threat posed by other states, and non-state actors, the UK should now consider the need to radically increase its defence spending. ISTAR capabilities would benefit from such investment.

16 April 2008

Memorandum from Intellect

Background

Intellect is the UK trade association for the IT, telecoms and electronics industries. Its members account for over 80% of these markets and include blue-chip multinationals as well as early stage technology companies. These industries together generate around 10% of UK GDP and 15% of UK trade. Intellect is a vital source of knowledge and expertise on all aspects of the hi-tech industry.

The following paper provides the initial views of Intellect member companies on the UK's use of Unmanned Aerial Vehicles (UAVs) within UK Intelligence, Surveillance, Target Acquisition and Response (ISTAR) capability. A high proportion of Intellect's members are active in Defence, and this submission draws on their views. This paper addresses those aspects specified in the Committee's call for evidence, and also raises issues that Intellect believes it is important to address in this inquiry.

Intellect welcomes the opportunity to provide input to the committee and is keen to engage with the committee, the Ministry of Defence, and UK Armed Forces to ensure progress on the issues raised in this submission.

Introduction

In 1998 a UAV crossed the Atlantic for the first time, covering 3270 kilometers in 26 hours and 45 minutes, and using a gallon and a half of fuel. To a casual observer, boundaries around aircraft effectiveness and efficiency had been shattered by this exciting new technology, which offered the potential to greatly reduce the exposure of aircrew to risk and to greatly expand military ISTAR capabilities. Subsequently, UK and allied forces have been able to exploit UAS for the benefit of operations and intelligence gathering, bringing immediate upgrades to tactical and strategic ISTAR capability.

Intellect recognises the various pressures which have surrounded the development of the UK's UAS capability up to this point, and those operational and financial constraints which continue to play a role. Given these challenges, UAS have in many ways been a success story for MoD, in terms of rapidly delivering increased capability to the front line. The committee's inquiry now offers the opportunity to step back and assess how well these technologies are being exploited, integrated with wider Defence capabilities, and developed for the future.

This paper does not address in detail the challenges to UAV capability which may arise from any future roles—for example weaponisation—and instead concentrates on the contribution that UAVs make to the UK's current and future ISTAR enterprise at the capability level.

Intellect's Position

Intellect believes that UAVs—and the Unmanned Aerial Systems (UAS) capability to which UAVs contribute—are an important example of the benefits which successful exploitation of technology in Defence can bring. As well as offering reduced risk for UK personnel, UAS have the potential to greatly expand the ISTAR capability available to the Armed Forces, and can often enable real efficiencies in terms of time and cost when compared to traditional alternatives.

Intellect believes that the challenges the UK now faces in seeking to improve on existing capabilities are as much cultural and conceptual as they are technical, and that to successfully exploit the potential of UAS within ISTAR a capability approach to its acquisition and employment is required.

As UAS become increasingly commonplace and experience of their utility in theatre grows, there will inevitably be increasing levels of demand for them to be deployed in a wide range of roles and environments. The future development of UAS must have flexibility as its first principle—both for the UAV platforms and the systems which enable them—so that this innovative new technology can bring benefit across UK Defence.

Current UK UAV Provision

In recent years UAVs have become an increasingly important part of MoD's ISTAR approach. A number of different UAV assets have been procured and have generated operational benefits—both in terms of effectiveness and lower human risk. Present deployments of UAVs deliver benefits in terms of force protection and situational awareness, broader data gathering through a range of sensors, and persistence.

The MoD has three types of UAV operating in the TELIC (Iraq) and HERRICK (Afghanistan) theatres, predominantly operating as collectors at various organisational and operational levels. Specifically:

- the strategic Reapers are tasked at Division level (and above) and controlled from a distance. Reapers are being deployed with the RAF;
- the Hermes 450s are a tactical asset, tasked at Brigade level, and under local control;
- the hand-launched Desert Hawk is tasked and controlled at Company/Platoon level. Both the Hermes 450s and Desert Hawks are deployed with the Army; and
- the long established Phoenix system should also be noted, having given good service in theatre and provided experience in the use and deployment of UAVs.

Intellect's membership believes that whilst the acquisition of UAVs has been beneficial, and has the potential to significantly upgrade the UK's ISTAR capability in future, this improvement will be stunted if the UK emphasises the acquisition of platform-based collectors over other parts of the system which allows intelligence to be effectively exploited.

Moreover, the four phases of the UK's intelligence processes—Direct, Collect, Process and Disseminate—must be adequately provisioned and balanced in order to deliver an optimal ISTAR capability. Intellect's members believe, however, that the tangibility and accessibility of UAV assets—which are effectively limited to the "collect" function—can lead to an imbalanced focus on these platforms. Whilst a vital collector, the UAV can only form one component of the wider UAS capability, and it is this capability which must be holistically developed in order to improve the UK's ISTAR provision.

Procurement and funding

The MoD has two parallel procurement streams in this area, the first of which is using the MoD's Equipment Programme (EP) to develop and procure "Watchkeeper", an advanced UAS incorporating both infrastructure and collectors, and will come onstream in 2010. At a cost of around £700m, Watchkeeper is the largest European UAV programme, and—laudably—is designed to provide not only the collector platforms but also the exploitation and dissemination systems which enable benefit to be derived from gathered information. At present, the Watchkeeper procurement is believed to be running to requirement, time and budget.

The majority of current UAS assets, however, have been not been acquired through the mainstream EP, but are the result of Urgent Operational Requirement (UOR) purchases. UORs have so far provided three Reapers (under a USAF managed Foreign Military Sales programme), twelve Hermes 450s (under the Lydian H450 service provision programme) and twelve Desert Hawk systems (each system with eight aircraft).

Some of the UAS UOR programmes have strayed from the traditional asset acquisition model of procurement: both the Hermes 450s and the Desert Hawks are provided as a managed service, where the MoD is procuring 'ISTAR by the hour'. This alternative—and overtly capability based—model may provide useful lessons for the future delivery of UAS.

The UOR programmes have brought immediate and vital benefits, delivering assets into theatre within a short timescale and enabling increased force protection via improved ISTAR capability. Industry believes, however, that some UORs are being funded by bringing money allocated to the DABINETT programme

forward—a measure which may generate future difficulties, as this programme was intended to provide a balanced capability across the Direct, Collect, Process and Disseminate phases. Using part of this funding to instead procure greater numbers of collector devices, in the form of UAVs, has created some unease within industry at a perceived expenditure imbalance between the gathering of information and its effective analysis and use.

Challenges

Intellect's members believe the UK has made significant progress in the exploitation of UAS, but that much of the potential of this system has yet to be tapped. There are a number of challenges, some of which are cultural, which must be overcome if the UK is to move from owning a collection of disparate UAV assets to deploying a truly strategic UAS capability.

It should be noted that whilst the UK's achievements in this area are some distance behind the advanced use of UAS by the US and Israel, comparisons with France—which has similar resources and aspirations for UAS—show that many of these difficulties are not unique to the UK. Contextual factors also exacerbate some of these issues, including UAS technology's relative novelty and the stresses and strains of ongoing operations.

Intellect believes that one significant challenge to effective exploitation of ISTAR—and indeed to wider Network Enabled Capability—is the lack of an integrated and cohesive UAS capability, incorporating legacy systems, current assets and future programmes. Whilst the growing collection of UAV assets offer an immediate low level of ISTAR support, the absence of effective integration prevents the UK's UAS assets operating as a true capability, and creates bottlenecks which prevent information from flowing freely between collection, decision and processing agents.

Specifically, this includes:

- technical interoperability (assets and networks);
- operational sovereignty;
- organisational interoperability;
- ownership of ISTAR assets;
- prioritising command and control of UAS;
- mission/command tradeoffs; and
- integration of UOR-procured assets.

MoD has recognised that the integration of UAS capability is a critical need, and its work to ensure interoperability on Watchkeeper shows positive intent to ensure relevant EP programmes are framed within an overall capability. What remains unknown, however, is how the UOR programme—which is likely to remain a feature of MoD procurement for some time—can be adjusted to ensure that COTS assets are similarly interoperable, and how ownership and tasking can best be arranged to manage UAS at a capability rather than service level.

As touched on in the previous section, industry believes that the perceived imbalance between collection and DPD presents a significant challenge. A bias towards the acquisition of increasing numbers of platform/collection assets rather than developing holistic UAS runs the risk of consistently gathering vast mountains of data which cannot then be analysed.

For example, Intellect's members are aware of an analysis which claims that 80% of the ISTAR gathering in support of Operation TELIC took place to acquire material which had in fact been collected previously, but was either not accessible or not known to be available. The operational and personnel risk and financial cost associated with re-gathering this material could potentially have been avoided had a more effective and holistic ISTAR capability been available.

Parts of MoD have repeatedly recognised that such an imbalance is nonsensical, but spending patterns have not significantly altered to rectify the shortfall. Despite assurances to industry that the Direct, Process and Decide (DPD) elements of the intelligence cycle should have priority over the Collect function, in the past year more money has been spent on UOR procurement of (mostly) collectors than on conventional procurement of ISTAR systems. There is clearly a mismatch between declared intent and actual procurement, which is further exacerbated by poor differentiation between intelligence requirements and collection requirements.

Exploiting Current ISTAR Capability

Given the challenges highlighted above, the full exploitation of current UAS provision is—in Intellect's view—dependent upon the successful integration of existing assets into an overall ISTAR capability. Members believe that better enabling the rapid management, analysis and dissemination of intelligence through interoperable components (including collectors) would enable greater exploitation of the information generated by UAS. This could, for example, make an immediate contribution to operational support areas like situational awareness.

In order to create this integrated capability, issues of organisational and management fragmentation need to be addressed. Intellect believes that unifying the disparate UAS ownership into an enterprise-level capability view would enable more strategic decision making, and facilitate better management of the different drivers and priorities within the UK's relatively limited UAS provision. A capability view would also enable an overall understanding of current expenditure, and thus facilitate a rebalancing of spending priorities to improve the previously underprioritised Direct, Process and Disseminate functions.

Development of doctrine and concept is needed to reflect the advanced capabilities of modern UAS, and to enable the structuring of the capability level management of UAS. In particular, the development of information exploitation and information assurance concepts should be an immediate priority. The further development of some evolving concepts around "non-traditional ISTAR", for example, could identify opportunities to draw other useful assets into the ISTAR envelope. Cross-fertilisation of training requirements and provision across the capability would also benefit from and contribute to an effective integration regime.

The NEC architecture which MoD is developing has the potential to enable the necessary technical integration. The architecture could allow ISTAR information to be created once and stored for use many times, so that the wealth of tactical information being generated by existing UAS assets is more consistently analysed and disseminated. The reduction of duplication in data collection and its associated costs would enable current UAS capability to support a wider range of operations in a wider variety of roles.

Integration through this architecture would allow exploitation capabilities to be shared more widely and enable greater scaleability and lower barriers to innovation. Open standards would also go some distance towards preventing proprietary lock-in and therefore enable a wider range of existing technologies to be brought to bear.

The establishment of an integrated capability could also allow the exploitation of additional sources of information, including for example data inputs from platforms such as attack helicopter, MSTAR, and sensors and sights on armoured vehicles. Future platforms, such as the Joint Combat Aircraft, could also integrate to provide data for ISTAR use.

Gradual improvements in UAS technology are inevitable given the relative youth of this area, and clarity on the integration and governance would essentially provide an overall roadmap for UK UAS, enabling incrementally developed technologies to be brought into the capability toolset.

Programmes already in development—notably Watchkeeper— show that the next generation of UAVs will offer substantial technological improvements over current models. Existing provision could, however, be improved by widening the range of sensors carried by UAS—currently this is limited to EO/IR and video, but members suggest the addition of complementary fielded airborne sensors such as radar and ES which can operate in adverse weather conditions and at longer ranges.

The UK's Approach to Future ISTAR

Partly because of the legacy of fragmented procurement and management of UAS programmes, a certain amount of confusion exists within industry over MoD's overall vision for future ISTAR. What is clear is that MoD and the services understand the potential benefits which can be derived from UAS, and across the board different programmes are being taken forward to deliver greater ISTAR capability to their owners. Notable by its absence, however, is a consistent strategic approach to the development of future UAS/ISTAR capability.

This lack of overall direction manifests itself through apparently contradictory developments. For example, MoD has stated that no further Reapers will be procured until the current fleet is brought into core programme management. However, there are no funded plans to do so, and the US has disclosed that it approved the UK's purchase of another ten platforms. Industry is thus unsighted about integration of current and future Reapers into the core programme, and also unsure as to why, again, stated intent and actual procurement seem to be at odds. Other UAS programmes (such as the Naval ISTAR UAV) have been initiated only to later be cancelled by MoD due to a lack of Departmental buy-in, leaving industry to question why time and resource was spent developing a programme without an agreed role in the overall capability.

Whilst some sensitivities remain in MoD around the perceived threat that UAS poses to manned aircraft programmes, the UK's continuing financial commitment demonstrates that the ISTAR community intends to continue developing UAS capabilities.

How to Best Develop Future ISTAR/UAV Capability

Intellect believes that the exploitation (rather than solely the gathering) of information must be the focus of the UK's future development of ISTAR capability. The future of UK UAS capability is as a key part of overall ISTAR, acting in concert with other components and capabilities across a range of roles and scenarios. Integration, both organisationally and technically, is the key which enables UAS to be deployed more flexibly, taking on more "dull, dirty and dangerous" collection tasks and allowing personnel to effectively exploit intelligence from its own and other sources.

Development of future ISTAR capability must therefore not be automatically conducted through the traditional—platform-based—procurement channels and processes. Acquiring and improving a capability throughout its life is a very different proposition to the one off purchase of a platform, and Intellect therefore reiterates its support for MoD's development of Through Life Capability Management (TLCM) processes. The Hermes 450 "ISTAR by the hour" procurement model shows that exploration of alternative acquisition approaches will be a large part of future ISTAR development—use of a "business services orientated" approach (for example) could incentivise innovation in service delivery, as well as unlocking MoD from the sort of platform or technology dependency which can result from procuring specific end solutions.

One key challenge which TLCM may only partly address is how to reconcile EP-procured UAS capabilities with the piecemeal approach delivered by UORs. The development of future UAS must, of course, respond to operational needs and provide the best possible capabilities for the personnel in theatre, and the unpredictable nature of UORs is no friend to overall capability planning. Looking forwards, however, development of UAS must incorporate the UOR process and be able to take a view across the full spectrum of capability. It is no use for MoD's development plans to only include a fraction of UAS projects and expenditure.

The flexibility of UAS means that there are many roles and capabilities which could be developed in future. Intellect's members drew particular attention to the development of mini-UAVs as one interesting example, because of their low unit cost, portability and suitability for difficult environments such as urban areas. High Altitude, Long Endurance (HALE) UAVs are also under development at present, and industry believe that the UK is well placed to deliver world-leading capabilities in this area, through projects like Zephyr.

Enthusiasm for the use of UAS outside theatre is likely to grow, and with this comes a further degree of complexity around the development of future assets. As has been well documented, certain of the UK's current UAS platform assets cannot be used in UK airspace (except in a very small number of test sites) and if MoD's overall vision of UAS capability includes use in non-segregated airspace then greater attention will need to be paid to the development of "sense and avoid" technology, redundancies and other safety measures, extended range, and different communications systems.

One role which looks set to be a part of the UK's UAS capability is that of armed or Strike UAS. Development of offensive UAS platforms—such as Taranis—is likely to be a focus for in the future, and doing so presents significant potential issues around how to manage the transition from ISTAR-focused single role UAS to strike-enabled dual role UAS. Many of the issues around management of the overall capability will need to be revisited—including ownership, command & control and doctrine—and there may also be sensitivities around using some alternative acquisition strategies for armed assets.

The development of autonomous UAS capability has also been the subject of much attention, and there are potentially significant efficiency benefits from self-tasking and self-managing systems, such as decreased risk from human error. Industry recognises, however, that the concept of introducing autonomous assets to theatre carries its own risks—both operational and political—and the successful deployment of this capability will depend heavily on the development of robust and accepted governance.

Information management is the most effective way to leverage available defence resource into optimum capability, and is therefore the key to the UK's ISTAR and wider NEC future. Intellect strongly believes that the development of future ISTAR capability needs to be conducted in partnership with industry. The technology industry which Intellect represents is a vital stakeholder in the future of UK defence, and is able to contribute cutting edge experience and expertise not only from UK defence but from work in other sectors.

Conclusion

Compared to the photogenic and iconic platform assets which have long dominated the public image of Defence, ISTAR is a relatively low profile capability, short on political saliency and long on thorny technological and management issues. It is, regardless, one of the most strategically important parts of future Defence capability—information superiority over adversaries is a critical need for UK forces in all types of warfare and peacemaking. Intellect believes therefore that the effective exploitation of information needs to be close to the top of MoD's priority list.

A unified approach to ISTAR assets' deployment and management needs to be considered, and whilst drawing this together from different Services, procurement methods and command layers may be uncomfortable, that it could be the key to enabling UK ISTAR to reach its full potential.

As MoD develops its future UAS, improving the exploitation of the information they provide must be as much of a priority as improving the UAV itself. Industry has confidence that this is recognised within MoD, but once the current Planning Round is settled will be keen to see that future actions match the abundant statements of good intent.

Intellect believes that technology offers HM Government the best opportunity to leverage the available resource into the optimum military effect, and UAS offer a clear example of technology being used to expand capability and lessen human risk through the exploitation of industry's expertise for the good of UK Defence.

21 April 2008

Supplementary memorandum from the Ministry of Defence

In recent years, Unmanned Aerial Vehicle (UAV) systems[3] have emerged as an important means of collecting Intelligence, Surveillance, Target Acquisition and Reconnaisance (ISTAR) information. They have become increasingly capable and, compared to manned platforms, are well suited to missions that are, for example, dangerous, monotonous or require very long endurance (the four Ds—dangerous, dirty, dull and deep). They are therefore often seen, when equipped with Full Motion Video (FMV) and in some cases radar and other sensors, as the right solution to ISTAR collection requirements at the Theatre/Operational, Formation/Higher Tactical, and Lower Tactical levels. The MoD Equipment Capability Customer is sponsoring a UAV capability investigation in collaboration with industry which will seek to establish the military requirement for UAVs out to the early 2020s and define how this could best be delivered. Additionally, this work will identify strategies in key areas such as spectrum management and airspace access to ensure that the equipment delivered can be fielded in the UK and on operations.

It is important to remember that UAV systems are one possible solution to the collection part of the ISTAR capability construct explained in the MOD Memorandum submitted in February 2008. To recap, the collection side aims to provide capabilities that can gather accurate and timely information across the environments and can detect, track, and identify enemy, neutral and friendly entities within a defined area, day and night, and in all weathers. The direction, processing and dissemination side aims to provide capabilities that can direct collection effort and then process and disseminate derived information and intelligence to all levels in national and coalition operations. As noted in the previous Memorandum, the emphasis of current and future ISTAR development is on improving the way the collection of information and intelligence is directed and the resulting data processed and disseminated.

UAV Systems Currently Operated by the Armed Forces[4]

The following UAV systems are being operated at present:

Reaper (formerly Predator B)

This Theatre/Operational level UAV system came into service in autumn 2007 to meet an Urgent Operational Requirement (UOR) for persistent ISTAR in Afghanistan. Reaper is a large UAV weighing about 4,500 kg and with a wingspan of 20 metres. It carries a FMV sensor and a Synthetic Aperture Radar (SAR) with Ground Moving Target Indication (GMTI) capability. It also carries a laser range finder and designator. It has an operational endurance of approximately 16 hours,[5] and can fly at up to about 240 knots. UK military personnel[6] fly the mission using beyond-line-of-sight satellite communications operating from a Ground Control Station (GCS) at Creech Air Force Base, Nevada USA. Take-off and landing of the UAVs in theatre is accomplished by a launch and recovery element manned by a mix of US and UK military personnel using line-of-sight communications. A total of two air vehicles and one GCS have been deployed to Afghanistan. A third UAV is due to be delivered in mid 2008 and a second GCS later in 2008. Planned enhancements include electronic surveillance and weaponisation of the UAV with multiple Hellfire missiles and GBU 12 precision guided bombs to improve prosecution of time-sensitive targets.

Combined Joint PREDATOR Task Force (CJTPF)

The UK also supports the operation of US-owned Predator-A UAVs by providing military operators and ground engineers to the US-led CJTPF. Most of the personnel are from the RAF. The commitment of personnel to the CJPTF is being progressively wound down during 2008 in agreement with the US as the UK focus shifts to the operation of the UK Reaper systems.

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[3] A UAV system consists of an air vehicle and associated payload (eg, sensors), communications, a control element often referred to as a Ground Control Station (GCS), support equipment and the human component which may include personnel such as the UAV-pilot, sensor operator, mission commander, maintainer and image analyst.

[4] The Phoenix tactical level UAV system operated by 32 Regiment Royal Artillery, the UK's first operational UAV, was taken out of service as planned on 31 March 2008.

[5] With crosswind limits and the lack of diversion ability of UAVs, operational flying is limited to around 11 hours so that 5 hours of fuel is kept in reserve in order to keep the UAV airborne if necessary.

[6] 39 Squadron RAF, working closely with Joint Force personnel in theatre.

Hermes 450

A Formation/Higher Tactical level UAV capability was procured as a UOR and entered service from July 2007. The capability is provided as a service by Thales UK using the Hermes 450 UAV system. The air vehicle is launched by a contractor-provided external pilot and operated throughout the mission phase by Royal Artillery personnel, with control handed back to the contractor for the recovery and landing. Servicing and support are the contractor's responsibility. Hermes 450 is a medium-sized UAV that weighs about 450 kg and has a wingspan of about 10.5 metres. It has an endurance of around 14 hours, but must remain in radio line-of-sight of the GCS. It operates at slower speeds and lower altitudes than Reaper. Up to 10 air vehicles and 6 GCS are being used, providing FMV ISTAR support in Iraq and Afghanistan with two concurrent missions possible in both theatres.

Desert Hawk 3

DH3 is a Lower Tactical level UAV system procured under UOR procedures in 2007. It is a hand-launched system that has an endurance of around 60 minutes. A total of 18 systems (144 air vehicles and 18 GCS) have been deployed in both Iraq and Afghanistan providing FMV ISTAR support to Battlegroup operations and below. The capability is operated by Royal Artillery personnel embedded in Battlegroups. A further five systems are being procured.

Buster

Buster was initially acquired for trials during early MoD investigation of mini-UAVs. The system did not meet operational requirements but after an upgrade was deemed satisfactory to support pre-deployment training. While less capable as an ISTAR platform than operational systems, Buster provides a limited UAV FMV capability, essentially simulating Hermes 450 and Desert Hawk systems on exercises.

As noted in the opening paragraph of this memorandum, UAV operations involve a degree of risk to the air vehicle and while operational procedures are aimed at minimising the loss rate, some losses can be expected. For example, on 9 April 2008 Reaper air vehicle made a forced landing whilst on an operation over a remote unpopulated area of southern Afghanistan. Sensitive items were recovered and the remaining wreckage was destroyed. The reason for the forced landing is under investigation but mechanical issues are suspected. The Department is seeking to replace the UAV. In Iraq, a Hermes 450 air vehicle crashed during an attempted landing in difficult weather conditions in January 2008. As at the end of February 2008, some 27 hand-launched mini-UAVs (Desert Hawk) had been lost over the previous 12 months.The Department is drawing the lessons from such incidents to add to its growing knowledge about UAV operations.

UAVs Currently in the Process of Being Acquired

WATCHKEEPER

The only Defence funded programme to field an operational UAV capability is for the WATCHKEEPER tactical UAV system. Main Gate approval was given in mid-2005. WATCHKEEPER is currently expected to reach Initial Operating Capability in the second half of 2010 and to reach Full Operating Capability in 2013. The system is being developed from the Hermes 450 system currently operating in Iraq and Afghanistan. The programme is due to deliver (including attrition stock) 54 air vehicles and 15 GCS and will provide the capacity to conduct up to 12 concurrent missions (or "lines of tasking"). It will be operated by 32 Regiment Royal Artillery. WATCHKEEPER is intended to support Land operations and is capable of carrying simultaneously three types of sensor: electro optical/infra-red FMV; SAR; and GMTI. In addition, it will carry a laser rangefinder/target marker. It will have UK-specific data links, have an automatic take off and landing capability and be able to use tactical landing strips. Overall, WATCHKEEPER provides greater capability compared to Hermes 450 and, subject to operational circumstances at the time, the intention is that it will start to take over from Hermes 450 from 2010.

As noted in the previous Memorandum, the DABINETT programme includes provision to improve deep and persistent ISTAR collection capability. The deep and persistent capability is likely to be a system-of-systems incorporating UAVs. However, the programme is pre-main gate and is currently exploring several ways of meeting the requirement. No decisions have been made on platform type.

Direction, Processing and Dissemination of Information and Intelligence from Current UAVs.

At the Theatre/Operational level in Afghanistan where Reaper operates, overall command is vested in Commander Joint Operations (CJO) at the Permanent Joint Headquarters (PJHQ) at Northwood, with control delegated to the coalition Combined Air Operations Centre (CAOC) in Al Udeid, Qatar. Reaper capability is made available to International Security and Assistance Force (ISAF) as a coalition asset in support of both UK and Coalition forces with tasking coordinated through coalition HQ in Kabul based on PJHQ/CENTCOM guidance. Reaper FMV imagery is down-linked to UK troops on the ground using Remote Viewing Terminals (RVT) such as ROVER to provide them with immediate situational awareness.

FMV and radar data is down-linked to in-theatre forces and image analysts in the GCS who conduct an initial analysis and provide immediate intelligence support to troops on the ground and to the tasking headquarters. Subsequent imagery analysis can be conducted by personnel at the GCS post-flight or in the coalition Intelligence Fusion Centre.

At the Formation/Higher Tactical level, where Hermes 450 provides an organic ISTAR asset supporting UK forces, overall command is vested in CJO at PJHQ, with control delegated to in-theatre Brigade Commanders. Tasking is coordinated through the Brigade or Battlegroup ISTAR cell and UAV tactical groups, with airspace co-ordination through the CAOC. The information and intelligence collected by Hermes 450 is currently being used in direct and immediate support of ground operations so there is only a limited requirement for processing and dissemination. Real-time FMV imagery is down-linked to the GCS and to RVT to provide immediate situational awareness. Initial analysis of the FMV is conducted by image analysts in the GCS and at Brigade Headquarters. Time critical intelligence derived from the FMV is distributed by voice to users without RVT access. Secondary exploitation of the FMV is conducted at the GCS or Brigade Headquarters and is distributed as required using the existing in-theatre communications infrastructure. Each Hermes 450 mission FMV is archived on DVD providing a limited capability to retrieve imagery for subsequent in-depth analysis.

At the Lower Tactical level, Desert Hawk is an organic ISTAR asset that provides dedicated support to UK forces. Like Hermes 450, overall command is vested in CJO at PJHQ, with control delegated to in-theatre Brigade Commanders, who may delegate to lower levels. Tasking of these assets is coordinated through the Brigade or Battlegroup ISTAR cell and UAV tactical groups. The information and intelligence collected by Desert Hawk is being used in direct and immediate support of ground operations so there is only a limited requirement for processing and dissemination. FMV imagery is down-linked to the mobile GCS and RVT, with initial analysis conducted by the operators or by Battlegroup intelligence staff at the GCS. The opportunities to store and retrieve Desert Hawk FMV for subsequent in depth analysis are very limited and is currently reliant on the transfer of data by CD to in-theatre image analysts.

Exploiting the Information and Intelligence Collected by UAVs

Current UAV capability is all procured under UOR arrangements and is proving very effective at providing troops on the ground in current operations with the real time imagery and enhanced situational awareness they need. Each system currently relies on dedicated GCS, communications and availability of compatible RVTs. The Department is looking to build on the successful, delivered capability and improve the exploitation of the information and intelligence collected by UAVs on current operations by improving connectivity between separate systems. This would optimise collection time and enable maximum analyst and end user access to information and intelligence, so improving timely exploitation of actionable intelligence and operational effectiveness. We are pursuing measures to provide a capability that specifically seeks to improve the processing and dissemination of all imagery (including FMV) gathered in support of operations, including that collected by UAVs. In addition, the Equipment Capability Customer is sponsoring a capability investigation into FMV coherence. This is seeking to identify improvements across all Defence Lines of Development in the direction, processing and dissemination of FMV products that can be quickly implemented on current operations.

For the longer term the Equipment Capability Customer has challenged UK industry to develop a common RVT that is able to accept an FMV feed from any UAV system. Work is also in hand to ensure that WATCHKEEPER is compatible with other UAV systems. The DABINETT programme is aiming to develop the coherence and networking of ISTAR assets across Defence, including UAVs. The planned delivery of an updated above Secret communications network will improve both the ability to exploit ISTAR capabilities and the subsequent dissemination of the derived intelligence.

We need to improve our ability to tag, store and retrieve data and to conduct more detailed secondary and tertiary analysis of the imagery. Such a capability would increase our ability to conduct pattern of life analysis, employ change detection techniques and provide imagery for evidential purposes. We are aiming to develop an archival, retrieval and dissemination architecture for the Afghanistan theatre that will address some of the immediate issues. In the longer term, the DABINETT programme will also address the issue.

The significant growth in coalition use of FMV and SAR/GMTI both by UAVs and other air platforms is placing an increasing strain on communications bearers as the bandwidth requirements increase and as the electromagnetic spectrum becomes increasingly crowded. As part of wider work on future requirements for UAVs, spectrum management issues will be addressed to ensure that the equipment delivered can be fielded in the UK and on operations.

The increase in FMV collection assets in theatre has generated increased demand for imagery exploitation. This is being addressed through the provision of analysis training for FMV operators, which is expected to ameliorate this problem significantly.

Airspace and Air Traffic Control

Current national and international regulations require UAVs to comply with exactly the same "ules of the Air"as manned aircraft. In practice the requirement to see and avoid other air users cannot currently be satisfied by any unmanned platform and for this reason all UAV operations in the UK (civil and military) are restricted to segregated airspace; in practice this constrains MOD UAV flying to military danger areas. In Iraq and Afghanistan, the airspace is under coalition military control so UAVs can operate more freely, although their operations need to be carefully organised, for example through restricted operating zones and air traffic management. Defence is part of a wider initiative to review regulations for UAV flying. Under arrangements led by the Assistant Chief of the Air Staff, the MOD is closely involved with the development of procedures and regulations to allow UAVs to operate in national and NATO airspace. These collaborative efforts involve engagement with NATO, European Defence Agency and Civil Aviation Authority and are intended to form the basis for agreement to support global solutions for UAV systems.

The following are the main current actions by the Department to address the regulatory, technical and cultural challenges for training and operational employment:

— The MoD is engaging with a number of national and international organisations that are developing the "Sense and Avoid" regulatory framework that will, in time, allow industry to develop technology that could allow UAVs to operate in non-segregated airspace.

— A small number of proposals to adjust current airspace arrangements are being taken forward through the civil authorities. The main one relates to an Airspace Change Proposal (ACP) to increase the airspace available to UAVs around the Salisbury Plain Training Areas.

25 April 2008

Memorandum from Thales UK

1. Introduction—UAVs in ISTAR

Unmanned Air Vehicles (UAVs) have a major contribution to make to the aerial surveillance component of Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) capability. UAVs:

— Do the "dull, dirty and dangerous" jobs for which manned aircraft are not suitable.

— Have performance characteristics unmatched, or not matched cost effectively, by manned aircraft including persistence (the ability to stay on station for very long periods of time), agility, and the ability to operate from rudimentary take off and landing sites.

— Make small demands on manpower, compared with manned aircraft.

— Are highly affordable and cost effective.

The air vehicles themselves can be—by comparison with manned aircraft—simple and flexible in design. From Thales's own experience, now building up in operational theatres, they can be highly survivable.

Whilst they offer similar or enhanced capability, they tend to be small compared with manned aircraft (the smaller the better, in general, in terms of survivability, flexibility of operations and affordability), but this itself sets technical challenges in terms of the weight and compactness of payloads. This is one reason why the systems aspect of UAV systems is challenging and important. A second reason is the importance of systems integration. The air vehicle itself is part of an integrated system that includes ground stations; and the integrated system itself needs to be integrated in a system of systems with other sensors and systems operating on the battlefield. At the level of tactical UAV systems, which is where Thales has its principal experience, the air vehicle component itself is a relatively small part of the total value of the system provided.

The detailed answers to the Committee's questions, below, draw principally on Thales's experience as the provider of the WATCHKEEPER Tactical UAV system for battlefield reconnaissance, and an interim system that is already in use in theatres of operations in response to an Urgent Operational Requirement. The memorandum aims to bring out, among other points, the significance of the systems aspect (emphasised above), and also the importance of an innovatory approach not only at the technical level but also in terms of the commercial construct used to meet the MoD's requirements. Above all it emphasises the vital contribution that UAVs make, not in some futuristic scenario, but in operations that are real today.

2. Thales UK—Global UAV ISTAR Systems Leader

Thales is a world leading international electronics and systems group, addressing defence, aerospace and security markets worldwide. The company is a prime contractor for the integration of systems across a wide variety of platforms as well as a provider of a wide range of communications and sensors technologies across all domains. Thales' leading-edge technology is supported by 22,000 R&D engineers who offer a capability unmatched in Europe to develop and deploy field-proven mission-critical information systems. The

company's civil and military businesses work together to share a common base of technologies to serve a single objective: the security of people, property and nations. Thales 2007 revenues were in excess of £8.3 billion. In the UK, Thales employs 9,000 people, with revenues in 2007 of £1.3 billion.

Thales holds a key European position in the provision of Intelligence, Surveillance, Target Acquisition and Reconnaisance (ISTAR) systems, including those that are based upon Unmanned Air Vehicles (UAVs), as well as other ISTAR-related capabilities including space surveillance, airborne radar systems (eg for Nimrod MRA4 and Sea King Mk7) and electronic intelligence systems. This understanding of the ISTAR domain led to the competitive selection, in July 2004, of Thales as the prime contractor for the UK WATCHKEEPER programme, currently the largest Tactical UAV programme in Europe. This has placed the company in a leading position to export UAV systems, a number of opportunities for which are being pursued.

The WATCHKEEPER system will provide the UK armed forces with a persistent Tactical UAV ISTAR capability for the next 30 years. Thales adopted a "capability based" approach to the programme which has been key in developing a solution which will fully meet the MoD's requirements and, in doing so, has created a significant UK industrial capability in the UAV systems domain, placing Thales among the world leaders. This industrial capability includes the ability to design and integrate the complex sensor systems that equip the UAV, the development of the sophisticated imagery analysis, dissemination and exploitation system, the manufacture and support of the air vehicles themselves and the provision of training services.

The programme has proceeded according to plan—without slippage to the contract—and also provided an invaluable UK knowledge base from which it was possible to deliver a major Urgent Operational Requirement (UOR) to provide Tactical UAVs to support current operations.

3. What Contribution UAVS are making to the MoD's Current ISTAR Capability

It is clear to Thales that UAV systems are already making a significant contribution to the MoD's current ISTAR capability and that this impact is set to increase as additional sensor types and capabilities are brought into service. UAVs are today performing "dull, dirty, and dangerous" roles at all levels of operations and are making a significant contribution to warfighting and force protection.

In June 2007, Thales was awarded a UOR contract by the UK MoD to provide UAV systems to support UK forces on current operations and provide an urgently needed ISTAR capability for UK forces. This UOR is being fulfilled by Thales through a highly innovative service provision contract ("ISTAR by the hour") and is today delivering high-quality imagery and image intelligence to the Land Component Commander after having been brought into service against a very aggressive timescale.

The contract includes the provision of Hermes 450 UAV systems, as well as training of the MoD staff in the use and maintenance of the system, and the provision of Contractor Logistic Support (CLS) and programme management services. This work is being managed by a joint Thales-Elbit facility in Leicester, which currently employs approximately 100 personnel and from which the WATCHKEEPER System is being produced.

The UOR capability is being delivered in several tranches. Thales' swift response enabled the first in-theatre delivery to be achieved on 14 June 2007. First flight was on 20 June 2007 and Initial Operating Capability (IOC) was declared on 5 July 2007. Since then, the Hermes 450 has been regularly flying in support of operations, providing persistent ISTAR coverage, delivering very high quality visual and IR imagery, day and night.

Within only two weeks of IOC, owing to the intensity of operations, the UAV systems were called upon to provide consistent and reliable ISTAR coverage over extended periods with only a 90-minute turn around time before returning to station. In theatre Battery Commanders highlight Hermes 450 as delivering truly reliable and stunning performance for our UK troops. The Hermes 450 ISTAR capability allows immediate and rapid reaction to a threat, with unmatched flexibility and minimum maintenance to support UK forces in adverse conditions. It has made a considerable difference to the UK capability. Since entering service in June 2007, the systems have flown more than 7000 operational hours, with up to 100 hours of continuous operations.

The capability delivers a mature, operationally proven air vehicle (with a pedigree of over 90,000 flying hours), long endurance and an extremely reliable UAV system with a high performance day/night payload and low in-theatre personnel footprint.

Three types of UAV are currently being flown to support operational UK missions: strategic, tactical and mini. Together these offer a layered approach to ISTAR coverage. Thales is the only UK-based provider of UAVs now offering UK operational capability.

Key benefits from this Thales system include:

- rapid entry into service;
- a "step increase" in dedicated ISTAR capability;
- enabling more efficient war fighting through safer, more timely and clear situational awareness for active operations;

— improved Force Protection and Counter Fires leading to reduced numbers of UK casualties; and
— provision of key Intelligence via a UK controlled communications infrastructure.

4. How the UAV Procurement Programmes Currently being run by the MoD are Progressing and how the Lessons from the use of UAVS on Current Operations are being Reflected in these Programmes

Both the programmes described above are tightly interlinked in that they draw lessons from each other. The air vehicle for the UOR, the Hermes 450, is a predecessor of the WATCHKEEPER air vehicle, and the UOR draws heavily on the knowledge of the WATCHKEEPER team. The WATCHKEEPER programme has in turn drawn a number of important lessons about training and deployment from the UOR experience.

Today, the key to success in the battlefield is to ensure that systems are integrated efficiently with a wide range of users to enable decisions to be taken at the lowest appropriate levels. The WATCHKEEPER system will provide this flexibility in decision making in addition to filling the capability gap in Image Intelligence. Additionally, the ground infrastructure, which is the core element of the WATCHKEEPER system, is ideally suited to provide the backbone of any future UAV system's data dissemination and exploitation.

WATCHKEEPER will provide the operational commander with a 24-hour, all weather, ISTAR capability supplying accurate, timely and high quality imagery to support decision-making. The system will consist of unmanned aerial vehicles, sensors, data links and ground control stations. WATCHKEEPER is to be delivered through an incremental programme to allow the system to benefit from both existing and developing sensors and air vehicle technology.

Major project milestones completed to date include the system design review in December 2005, the preliminary design review in July 2006 and the critical design review in December 2006. The WATCHKEEPER programme is on track, with Thales meeting the schedule for all the customer-agreed programme milestones and, in 2007, unveiled the new WATCHKEEPER air vehicle as the programme moves forward to manufacture and testing phase. The most recent milestone was the successful first flight of the WATCHKEEPER air vehicle, which took place on 16th April 2008. The programme is on track for the planned in service date of 2010.

In 2005 the NAO report on driving the successful delivery of major defence projects highlighted the WATCHKEEPER programme as an example of gold standard best practice in the client-contractor relationship.

Key elements of the Hermes 450 UOR solution provide the basis for the WATCHKEEPER tactical intelligence system. The Thales solution is underpinned by an extensive understanding of UAV operations in general, and the Hermes 450 UAV capability in particular, gained during the previous five years of the WATCHKEEPER assessment phase. This knowledge base provided the company with the confidence to offer a Hermes system to the UK and the company is now utilising its growing expertise in this niche area and is being asked to offer this capability to other allied nations.

The MoD has commented that the delivery of the complex Hermes 450 UOR capability on schedule in just six months has been an exciting challenge. The Hermes 450 UAV system augments the MOD's current capability and significantly increases the intelligence available for those members of our Armed Forces currently on deployment around the world.

Key lessons have been learned as the WATCHKEEPER programme has evolved particularly in system design, exploitation and dissemination of information and operational training. These lessons have enabled a step change in capability for the Hermes 450 deployment and a far better understanding of the concept of ISTAR requirements for UAVs from a tactical viewpoint. Additional lessons have been learned regarding the adaptability of UAVs and their reliable persistence. UAV ISTAR coverage to Forward Air Controllers has proved an essential tool in providing direct image intelligence and Full Motion Video (FMV) via Remote Viewing Terminals (RVT).

This innovative approach by Thales of an ISTAR service provision not only provides a fast and effective solution to an urgent operational need for persistent image intelligence at the front-line but also supports the longer-term introduction into service of the far more capable WATCHKEEPER system.

5. How the Information/Intelligence Collected from Current UAVS is Used and What Factors are Limiting the most Effective Use of this Information/Intelligence (for example the Systems Which Process and Disseminate the Information/Intelligence Collected)

The Hermes 450, provided by Thales under the Tactical UAV UOR, is regularly flying in support of operations, providing direct enhanced and persistent ISTAR coverage, delivering very high quality visual and IR imagery, day and night direct in theatre to ground forces. In the short time since it entered service, the Hermes 450 has become an essential asset to the land commanders in theatre. It provides Full Motion Video (FMV) and intelligence information to UK Military Forces image analysts and Forward Air Controllers via ground control stations and Remote Viewing Terminals (RVTs).

MoD has provided indications from theatre that the quality and utility of the Hermes 450 Tactical UAV System are far in excess of what has been available previously. UAVs are proving to be an absolutely essential battle-winning piece of equipment. Despite the very high quality visual and IR imagery working in a congested communications network, the system allows the MoD Headquarters to communicate with the Ground Control Station to effect in-flight re-tasking. As a result, the quality and stability of the sensors provide a unique ISTAR capability in theatre. Hermes 450 is the FMV "platform of choice" in theatre and, as a result, the system is currently providing the principal FMV capability in the operational theatres. Additional systems have now been delivered and operations in both theatres will "ramp up" providing continuous ISTAR support to theatre troops over a wide area.

ISTAR information is only as good as the bearers of information and an effective information management, exploitation and dissemination system is key. Thales experience indicates that having as broad a user community as possible, supported by timely and accessible information, is critical to the success of an ISTAR system—and this is the basis of the system currently under development for WATCHKEEPER. This capability is not currently available to support current operations and there will be significant operational benefits when a more widely available image reference library and intelligence reference library are deployed as this will result in the sharing of information across the UK Forces through a networked ground infrastructure.

Thales believes that there is a strong value for money argument for the WATCHKEEPER system to provide the basis for the UK based NEC Ground Infrastructure exploitation and dissemination capability as one of the key components to integrate the layered manned and unmanned ISTAR collector systems across the different layers of command for maximum UK Forces benefit.

6. Whether the MoD is Exploiting Fully the ISTAR Capabilities Offered by UAVS (Including Drawing on the Experience of its Allies)

The Hermes 450 UAV UOR capability has highlighted the significant demand for UAV ISTAR capability in operational theatres. Although initial first generation UAVs were "stove pipe" systems, the provision of the Hermes 450 Full Motion Video (FMV) enhancements and access to down linked Remote Viewing Terminals (RVTs) are now providing key ISTAR information to ground forces in a timely and effective manner. This new capability allows forward deployed troops to view imagery direct from the UAV, even when closely engaged in battle. Following on from the UOR capability, WATCHKEEPER will provide a further step change in ISTAR capability, with more capable sensors (including synthetic aperture radars and ground moving target indicators), improved operability through automatic take off and landing and most importantly through the ground information management infrastructure. Beyond this further capability enhancements are envisaged and some of these new concepts are now being considered actively by MoD.

Thales is supporting the assessment of these future capabilities using "synthetic environment" suites that have been developed through considerable private venture investment by the company. These facilities provide a range of capabilities that allow the evaluation of problems at a number of levels of complexity, and are used by Thales both for internal purposes and in partnership with the MoD community, including joint UK operations and allied nations.

These facilities (the Thales ISTAR Battlelab and the Group Operational Analysis Laboratory (GOAL)) provide Joint industry/MoD experimentation to assess comparative benefits (detail, coverage, timeliness, interpretation, and communication) in the battlefield of the following assets and capabilities:

- alternative sensors and technologies;
- improved communication networks enabled by UAV payloads;
- advanced image and data exploitation packages;
- cross-cueing and integration to effect systems;
- cross-cueing to other ISTAR assets (manned and unmanned);
- utility vs distraction of ubiquitous demands for Full Motion Video to all at all times;
- benefits/impact/penalties of data link/Network bandwidth management by the use of Imagery on Demand, variable data compression; and
- implementation of the WATCHKEEPER wider Image Reference Library.

In order to support the MoD in its current and future analysis of tactical UAV operations the GOAL facility is being used extensively alongside current operational UAV experience to develop and recommend future ISTAR capability requirements.

The Thales ISTAR Battlelab facility is a key capability, allowing evaluation of many aspects of warfare across all the Defence Lines of Development (DLODs) and it has provided a significant contribution to the Thales WATCHKEEPER programme. Thales, using the ISTAR Battlelab, has been involved in several projects, including NITEWorks (Network Integration Test and Experimentation works), JUEP (Joint UAV Experimentation Programme for UAV interoperability with Maritime and ISTAR platforms) and Pre Deployment ISTAR Training with 3 Commando Brigade and 12th Mechanised Brigade littoral warfare.

This involved a warfare experiment for the command support group incorporating ISTAR planning, management, tasking, processing, exploitation and distribution with all users in the loop whilst providing essential UAV Concept of Operations (CONOPS) evolution within the Thales Battlefield Transformation Centre (BTC).

With this facility Thales provides the UK MoD and its Allies with the ability to access CONOPS, doctrine, training needs, best practices and realistic operational scenarios for UAVs in ISTAR. Thus, the UAV system has become a fundamental part of the layered approach to ISTAR through placing the most appropriate collection asset in the most appropriate area to support troops on the ground. This cooperative and embracing approach with a wide dissemination of information to all those that need it is key to overall success in operations.

7. How the Current and Future ISTAR Capabilities Offered by the UAVS are Informing the MoD'S Overall Approach/Direction Relating to ISTAR

This question is for MoD not industry to answer but just as Thales has learned a great deal about the capability, operation, and support of UAV systems, and the management of their lines of development including training, from experience so far, we are confident that the same is true for MoD. Looking to future systems, Thales has been extensively involved in paving the way for future ISTAR capability through research and experimentation activity including the Joint UAV Experimentation Programme described above, the use of the Thales Battlelab and participation in NITEworks (Network Integration Test and Experimentation Works), an ongoing programme that enables MoD to assess the benefits of Network Enabled Capability.

8. How the Use of UAVS, for Training and on Operations, Impacts on Airspace and Air Traffic Control

Thales fully recognises the importance of achieving, safe, effective airspace management procedures and processes for UAV systems. This is helped by Thales's role as Europe's largest supplier of Air Traffic Management systems and equipment. Airspace management is critical to not only the effective use of military UAVs but also the potential for future civilian UAV usage.

For current UAV operations the UK MoD operate a fully controlled airspace management capability. The Thales Hermes 450 fits seamlessly into this environment under the control of the System Mission Commander providing situation awareness and Air Traffic co-ordination. For WATCHKEEPER a similar approach will be adopted, with further advantages by providing enhanced onboard Air Traffic Control (ATC) communication links with air traffic control. The WATCHKEEPER system has a dedicated Tactical Vehicle and Communications (TAC) party which can be embedded with the Combined Air Operations Centre or higher headquarters to allow WATCHKEEPER missions and a mission control to be closely coordinated within an agreed airspace. The TAC party requests planned Airspace access for airspace co-ordination in conjunction with other air assets. This is a continuous approach as mission re tasking occurs.

With respect to operating UAVs in segregated airspace, Thales is at the forefront of this activity and is providing Synthetic Environment Training for UAV systems training outside of the operational environment. This is in addition to the individual operator training for UAV systems that may be contracted as part of other programmes. Thales is also a leading player in technology research and engagement with the regulatory authorities (eg CAA, FAA, Eurocontrol, EASA and ICAO) for UAV flights in non-segregated airspace.

Thales flew the Hermes 450 at ParcAberporth, Wales, in September 2005. This marked the first time that a UAV of this size had ever been flown in Civil and Military UK airspace. This was a major step forwards for the UK, as until UAVs can be operated in integrated airspace their uses within the homeland security and civil domain will be limited. Through its UK pedigree Thales is well placed to access this capability for homeland security and civil market opportunities.

Thales is a key player in the UK ASTRAEA (Autonomous Systems Technology Related Airborne Evaluation and Assessment) programme. This is a joint collaborative UK Government and Industry initiative to establish the necessary technology, procedures and regulations to enable the routine operation of UAVs in all classes of airspace. ASTRAEA examines areas such as Sense and Avoid, Communications, Mission Management, Adaptive Routing, Airworthiness Certification, Decision Making and other Regulatory Aspects. Of those, Thales leads the Sense & Avoid, Mission Management, Adaptive routing strands and regulatory engagement for the consortium.

Current manned aircraft regulations assume the presence of an on-board pilot and so ASTRAEA is investigating and developing technology solutions to perform equivalent functional performance while working with the regulators to interpret and develop appropriate guidance and regulations.

Engagement of the wide stakeholder community is being achieved by a combination of synthetic environment experimentation and demonstration of potential technological solutions along side review of regulatory guidance.

Integration of UAVs into non-segregated airspace is a global issue and the programme is working with many international agencies to co-ordinate activity with the ultimate aim of generating agreed standards.

9. Summary

Thales is a major global player in Aerospace, Defence and Security Technology. Thales is also a world leader in ISTAR systems, where particularly in the UK it is the leader in UAV systems and technology as prime contractor for the MoD's £700 million WATCHKEEPER programme (Europe's largest tactical UAV programme).

The WATCHKEEPER programme will provide a network enabled ISTAR capability through the integration of a sophisticated suite of sensors, communications and imagery exploitation and dissemination systems. WATCHKEEPER is on track for its In Service Date of 2010. Thales believe that there is a strong value for money argument for the WATCHKEEPER system to provide the basis for the UK based NEC Ground Infrastructure exploitation and dissemination capability.

In support of current operations, Thales is again the prime contractor and, indeed, the only UK company to have operational UAVs in service with the UK Armed Forces. Thales is providing an innovative Service based procurement solution using the Hermes 450 UAVs in Iraq and Afghanistan. To date, these systems have flown 7,000 hours in theatre and is providing a step change in ISTAR capability supporting UK troops in their missions.

Thales is also heavily involved in the future development of the use of UAV systems in the UK, in particular through the UK ASTRAEA programme which is taking forward the UAV access to airspace and air traffic management.

Thales is making an essential contribution to the UK's delivery of current operational UAVs, the UK's MoD WATCHKEEPER programme and the development of military, homeland security and civil UAV technologies. Thales is at the heart of UK ISTAR and UAV systems capability.

25 April 2008

Memorandum from the Civil Aviation Authority

Introduction

1. The Civil Aviation Authority (CAA) is responsible for the regulation of civil aviation in the United Kingdom and has specific responsibility for aviation safety, airspace policy, consumer protection and economic regulation.

2. The House of Commons Defence Committee has announced that it is undertaking an inquiry into ISTAR (Intelligence, Surveillance, Target Acquisition and Reconnaissance) and specifically the contribution of Unmanned Aerial Vehicles (UAVs)[7] in providing ISTAR capability. The inquiry is examining a range of issues relating to UAVs, including how the use of UAVs, for training and on operations, impacts on airspace and air traffic control. As such, the CAA has been invited to provide a written submission to inform the Committee. This Memorandum focuses on the work of the CAA's Directorate of Airspace Policy and Safety Regulation Group.

Statutory Authority

3. The CAA's statutory obligations are set out in the Civil Aviation Act 1982 and in the Transport Act 2000. The CAA's principal duty in respect of air navigation is to maintain a high standard of safety in the provision of air traffic services and, as required by the Transport Act 2000, the CAA is the Airspace Approval and Regulatory Authority for the UK operating under Directions given jointly by the Secretaries of State for Transport and Defence. Policy for the use of UK Airspace by civil and military users is determined by the Director of Airspace Policy.

4. The Directorate of Airspace Policy is charged with securing the most efficient use of airspace consistent with the safe operation of aircraft and the expeditious flow of air traffic whilst taking into consideration the requirements of operators and owners of all classes of aircraft. Environmental implications and national security issues must also be considered. The Civil Aviation Authority (Air Navigation) Directions 2001 lay

[7] The term UAV refers to the air vehicle part of the Unmanned Aircraft System (UAS). The UAS also incorporates the Ground Control Station (GCS) and any other UAV System Elements necessary to enable flight, such as a Communication Link and Launch and Recovery Element.

down the obligation upon the Directorate to develop, promulgate, monitor and enforce policies for the sustainable use of UK airspace and for the provision of necessary supporting infrastructure for air navigation.

5. The CAA's Safety Regulation Group (SRG) performs the CAA's safety regulatory functions. SRG achieves this, in partnership with industry, by driving continuous improvements in aviation safety in the UK and, in partnership with, amongst others, the European Aviation Safety Agency (EASA), across Europe. Generally, airworthiness responsibility related to UAVs with a weight in excess of 150 kg now rests with EASA. Airworthiness regulation for civil UAVs with a weight below 150 kg (or those above 150 kg that fall outside of EASA regulation eg customs, police or similar services and aircraft specifically designed or modified for research, experimental or scientific purposes, and likely to be produced in very limited numbers) is the responsibility of SRG which also has regulatory responsibility for the UK Air Traffic Services.

United Kingdom Airspace

6. UK airspace is divided into various classifications in accordance with International Civil Aviation Organisation (ICAO) practice and each class of airspace has different rules and regulations. Classes A, C, D and E[8] (Controlled Airspace) place more stringent demands on aircraft and pilot in terms of equipment and qualification. Access is, in the main, subject to Air Traffic Control permission thus creating a known traffic environment affording increased protection for aircraft operating therein. The remaining airspace categories (outside Controlled Airspace) are Classes F and G. This airspace is accessible without permission and, as an Air Traffic Control service is not mandatory, the responsibility for separation and collision avoidance lies squarely with the pilot under the principle of "see and avoid". That said, Air Traffic Control services are available in Classes F and G airspace upon request, subject to availability.

7. The long term industry aspiration is that UAVs will be permitted to fly in exactly the same airspace as manned aircraft. An essential prerequisite will be that UAVs will need to meet all existing safety standards applicable to manned aircraft, which are appropriate to the class of airspace within which they are intended to operate. However, this will not be permitted until the UAV industry can demonstrate that UAVs have an "equivalent" capability to manned aircraft in a number of respects, including safety. Airworthiness of the aircraft is an issue being monitored by the CAA's Safety Regulation Group. In airspace terms, the critical issue will be the development of a technical solution replicating the ability of a pilot of a manned aircraft to see and avoid other aircraft. The latter requirement has yet to be overcome and therefore, for the time being UAV flights that take place beyond line of sight[9] are restricted to such airspace as can be segregated from other airspace users. The operation of UAVs must also be transparent to the ATC system which means that an air traffic controller providing a service should expect a UAV to react to control instructions in the same way as would a manned aircraft. To date, the impact of UAVs on UK airspace and Air Traffic Control has been minimal; however, there are clear indications that the demand for segregated airspace is on the increase, both from UK industry and from the MOD.

8. In the UK, segregation is achieved by restricting UAV activity to the confines of existing or newly established Danger Areas. On a temporary basis, segregated airspace can take the form of Restricted Area (Temporary), which can be established under Article 96 to the Air Navigation Order 2005 where it would be in the public interest to do so or in the interests of national defence; however, the establishment of a Restricted Area (Temporary), as opposed to the utilisation of existing Danger Areas, places further restrictions on other airspace users.

UAV Activity

9. A significant increase in both civil and military UAV flying is anticipated, most of which will require access in the future to all classes of airspace if it is to be operationally effective and/or commercially viable. The CAA is involved in a number of working groups to ensure the demands and requirements of UAV operators and other airspace users are met. The CAA is represented on an International Civil Aviation Organisation (ICAO) Study Group, which is developing international guidance on the operation of UAS and is also engaged with a major European body (EUROCAE) which is developing UAV standards. Furthermore, by ensuring it is at the forefront of this emerging activity, the CAA has the opportunity to influence other regulators (such as the European Aviation Safety Agency and the Federal Aviation Administration) to maintain an acceptable level of safety for all aircraft and airspace users into the future. The recent amendment process to update Civil Aviation Publication (CAP) 722: Unmanned Aircraft System Operations in UK Airspace—Guidance has been a collaborative approach with significant input from industry and the MoD. To ensure a co-ordinated approach across all relevant disciplines, the CAA has established committees to address UAV issues that involve all relevant CAA departments as well as industry representatives.

[8] There is no Class B airspace established in the UK.
[9] Beyond line of sight is considered to be a range exceeding 500 metres from the operator and/or 400 feet above ground level.

10. In terms of military UAV flying within the UK, the prime activity is for training, which, at present, is confined to existing Danger Areas; however, the acquisition of systems such as Watchkeeper has led to a growth in demand for airspace to enable UAV training missions to be conducted in a realistic environment. As previously stated, before UAVs can be safely integrated with other airspace users, UAV operators would be required to work within the same regulatory framework as that of manned aircraft operating in the same class of airspace. As such, current MoD and industry UAV operations, beyond line of sight, will take place inside Danger Areas or other segregated airspace. The following points are of note:

(a) Whilst manned aircraft can utilise the principles of "see and avoid" to visually avoid colliding with other aircraft, UAVs do not yet have an equivalent method of aerial collision avoidance. "sense and avoid" systems are under development to emulate this manned aircraft capability; however, it is unlikely that a system which is acceptable to civil regulatory authorities (and by implication, other airspace users) will be available for some time.[10]

(b) It is CAA policy to utilise Danger Areas as a method of segregating UAV activities; however, it is recognised that this may be misinterpreted to mean that the activity is in some way dangerous. While the flight may not in itself be considered dangerous, with the lack of a "sense and avoid" capability the UAV activity requires an enhanced level of protection from other airspace users, which can best be catered for by using Danger Areas.

(c) In all aviation activities, including UAVs, it is essential that the risk of endangerment to people and property on the ground, as well as to other aircraft, be avoided. As such, for a UAV that has not yet gained an airworthiness certificate or a military release to service, flights may be restricted to segregated airspace over land or sea that is devoid of people and property to ensure that third parties are not exposed to any unacceptable risks. This issue is carefully considered when establishing segregated airspace and has been a key factor in the development of the UAV flight test and trials facility at ParcAberporth in West Wales with its access to Danger Area EG D201.

11. With the future introduction of Watchkeeper, it was recognised that the size of the Danger Area complex in the vicinity of Salisbury Plain would not allow the UAV to utilise its full ISTAR capabilities due to the standoff range required for its sensors, ie the capability to operate at range from their intended target. As such, a proposal has been put forward by the MOD to establish additional Danger Areas to the south of the existing Salisbury Plain Training Areas. The Airspace Change Process is being conducted in accordance with CAA policy as set out in Civil Aviation Publication 725. Whilst this will clearly have an impact on other airspace users, full consultation will take place with, amongst others, the aviation community to ensure that the available airspace can be used in a safe and efficient manner and that the new Danger Area structure is proportionate to the MOD's needs and has the minimum impact on other airspace users.

12. The CAA is aware of the UAV industry's view on the benefits that the operation of UAVs may bring, and will apply its best efforts to meeting the reasonable demands of this sector, whilst balancing those against the needs of the manned aviation industry. It is recognised that the requirements for UAV operations inside Controlled Airspace, in terms of procedures and equipment carriage, may differ from operations outside of that more stringent regulatory environment; however, the basic remit for collision avoidance is the same in all classes of airspace. Detailed policy has yet to be established in some areas, which will be progressed by the CAA with all interested parties playing a significant role. However, UAVs will be segregated from other traffic until an acceptable collision avoidance system has been developed and is in place.

Conclusion

13. The CAA is alert to the airspace requirements of all users, including operators of UAVs, and is working closely with stakeholders to ensure a collaborative approach in determining evolving policy related to UAV operations. UAVs are expected to play a significant role in a number of military and civil areas and it is important that the abilities of these platforms are exploited fully. In the short term at least, it is anticipated that these operations will be significantly different in their profile and requirements from manned aircraft operations. It is anticipated that future airspace arrangements will need to cater for all types of UAV operations and access to all classes of airspace. The need for safe integration without compromising current levels of safety is evident. The CAA has played, and continues to play, a lead role in this regard.

29 April 2008

[10] Latest estimates, although not guaranteed, for a "sense and avoid" system range from 2012 to 2014.

Memorandum from Northrop Grumman

In response to the House of Commons Defence Select Committee's request for evidence for the Defence Committee inquiry into ISTAR (Intelligence, Surveillance, Target Acquisition and Reconnaissance) and the role of Unmanned Aerial Vehicles (UAV), Northrop Grumman is pleased to submit the following information.

Executive Summary

1. This submission records the views of Northrop Grumman on UAVs in providing ISTAR capability based on the company's extensive experience in the United States in developing UAVs with the US Air Force, US Army and the US Navy.

2. UAVs are transforming the battlefield in Iraq and Afghanistan. Future conflicts will see their role expanded dramatically. In war-fighting situations, they offer shortened target engagement timescales compared to conventional platforms. For peacekeeping and peace enforcement missions, they offer vital persistent ISTAR capabilities. Within the US Armed Forces their use is already widespread, while, in the UK, the MoD has made UAVs a strategic priority.

3. ISTAR is a key military capability that generates and delivers specific information and intelligence to decision makers at all levels in support of the planning and conduct of military operations. UAVs play an important role in Network Centric Warfare/Network Enabled Capability concepts in both the US and Europe and are becoming a key element in the inventories of the world's militaries. Full exploitation of the operational benefits of UAVs is only possible in a joint integrated and network-enabled system.

4. Northrop Grumman has a 60-year history of providing more than 100,000 unmanned systems to military customers in the US and around the world. Its current portfolio spans a variety of different platforms: the high-altitude, long-endurance RQ-4 Global Hawk for the US Air Force and Navy; the MQ-8B Fire Scout helicopter for the US Navy and Army with the ability to take off and land autonomously on any aviation-capable warship and at prepared and unprepared landing zones; the MQ-5B Hunter medium-altitude UAV first fielded for the US Army in 1996 to provide dedicated reconnaissance, surveillance and target acquisition capability, relaying information real-time via video link to ground forces; and the stealthy X-47B Unmanned Combat Air System (UCAS) for the US Navy. The Navy UCAS will perform the first ever at-sea aircraft carrier launches and recoveries with a fixed-wing unmanned air system in addition to autonomous refuelling in midair demonstrating the capability of an autonomous, low-observable air vehicle.

5. The Global Hawk UAV developed for the US Air Force is a fully autonomous high altitude long endurance unmanned aerial system. It can autonomously, taxi, take off, fly, remain on station while capturing imagery, return and land. It provides persistent intelligence, surveillance and reconnaissance and is designed to fly up to 65,000 ft for more than 35 hours. Global Hawk is monitored during its flight by ground-based operators who can alter the system's flight path and sensor operations.

Background

6. Northrop Grumman is a global defence and technology company and provides products, services and solutions in systems integration, defence electronics, information technology, advanced aircraft, shipbuilding, and space technology. With headquarters in Los Angeles, California, the company employs more than 120,000 people in 25 countries serving international military, government and commercial customers.

7. Northrop Grumman has a long standing relationship with and presence in the UK dating back more than 20-years. The UK remains a critically important market for the company as a supplier base and a source for technology partners. Northrop Grumman's annual spend in the defence and aerospace industry supports thousands of jobs around the UK generating intellectual property and facilitating exports. There are more than 700 Northrop Grumman employees in locations across the UK at Chester, Coventry, Fareham, London, New Malden, Peterborough, RAF Waddington and Solihull, providing avionics, communications, electronic warfare systems, marine navigation systems, C4I and mission planning, aircraft whole life support, robotics, IT systems and software development.

Medium Altitude Extended Range Capability

8. The Northrop Grumman MQ-5B Hunter UAV has been the workhorse unmanned aerial system for the US Army since it was first fielded in 1996. It has more than 60,000 total flight hours and 36,000 combat flight hours. Deployments include Macedonia in support of KFOR from 1999 to 2002 and continuous deployment in Iraq from 2003 to the present. It has also been deployed with the US Department of Homeland Security in customs and border patrol operations.

9. The Hunter MQ-5B is a Brigade level reconnaissance, surveillance, target acquisition, and weapons platform. It has an endurance of 21 hours, airspeed of 80 Knots cruise and 110 Knots dash and an altitude of 18,000 feet to 20,000 feet. The Hunter can carry a payload weight of up to 430 lbs. The standard payload is an electro-optic (EO)/infra-red (IR) sensor.

10. It is currently the only operational UAV with a heavy fuel engine which provides logistics supportability with armoured units on the ground. Hunter can be operated by forward deployed operators from unimproved runways providing high military utility to mobile forces. The aircraft has highly redundant mission and propulsion systems, has an auto take-off and landing system, and has demonstrated operational availability of 99.3%.

11. The Hunter unmanned aerial system is operated and maintained on a 24 hour per day, seven days per week basis in Iraq by a contractor team under a Government owned-contractor operated (GOCO) arrangement in support of INSCOM and the Combat Aviation Brigade which deploys the aircraft.

12. A video can be made available to the Committee showing an actual engagement by the US Army, 25th Combat Aviation Brigade with terrorists during an improvised explosive device (IED) emplacement. This video will demonstrate the utility of UAVs in the counter IED scenario.

High Altitude Long Endurance Capability

13. The Northrop Grumman RQ-4 Block 10 Global Hawk UAV is currently supporting the US Air Force. To date three Global Hawks are deployed in support of US military operations, logging more than 15,700 combat hours conducting intelligence, surveillance and reconnaissance missions and with more than 21,000 total programme flight hours and 95% mission effectiveness. These UAVs are operated overseas by USAF pilots from a mission control element stationed at Beale Air Force Base in Northern California. The UAV is equipped with EO/IR and synthetic aperture radar (SAR) sensors to provide high-quality real-time imagery.

14. Global Hawk has been used in border patrol missions in Iraq since 2003. Missions are typically of 24-hour duration. Imagery is collected using SAR and EO/IR sensors. The long endurance allows multiple passes over the same target. Early in a mission the operator may use SAR. In good weather conditions this may be switched to using EO/IR cameras on the same target. The IR capability can be used at night to monitor changes in activities. Global Hawk can also be used before and after IED missions allowing pre-detonation and ground patrol route planning. Images collected are transmitted via satellite to imagery analysts at the Distributed Common Ground Station. The high resolution data is exploited within 20 minutes and the raw imagery is posted on a secure military website within minutes for use by anyone with access around the world.

15. The Global Hawk has autonomous high-altitude, long-endurance (HALE) flight characteristics. The air vehicle flies at altitudes up to 65,000 feet for up to 35 hours at speeds approaching 340 knots. It can image an area the size of the state of Illinois in just one mission. During its trials with the US Air Force's 31st Test and Evaluation Squadron and during its first deployment in Operation Enduring Freedom, the Global Hawk system was shown to be flexible and dynamically re-taskable.

16. Two Block 10 Global Hawks are also currently being used in the U.S. Navy's Global Hawk Maritime Demonstration (GHMD) programme. Stationed at Naval Air Station Patuxent River, Maryland, the air systems are being used to help define the concept of operations for maritime surveillance.

17. The US Air Force's desire to expand Global Hawk's role supporting the service's ISR mission launched the development of a more capable and powerful unmanned surveillance system, the next-generation Block 20 Global Hawk. Its first flight was in March 2007.

18. The larger more capable Block 20 aircraft will carry up to 3,000 pounds of internal payload and will operate with two-and-a-half times the power of its predecessor. Its open system architecture, a so-called "plug-and-play" environment, will accommodate new sensors and communication systems as they are developed to help military customers quickly evaluate and adopt new technologies.

19. The US Navy has recently selected a marinized version of the RQ-4 Global Hawk unmanned air vehicle as the platform for the Broad Area Maritime Surveillance Unmanned Aircraft System (BAMS UAS) programme. This will provide the US Navy with a persistent maritime intelligence, surveillance and reconnaissance (ISR) system to protect the fleet and provide a capability to detect, track, classify, and identify maritime and littoral targets.

20. In October 2003, the US Air Force demonstrated Global Hawk's capabilities to the German Ministry of Defence (MoD) in northern Germany. A Block 10 Global Hawk equipped with an EADS electronic intelligence (ELINT) sensor prototype performed a series of flight demonstrations over a six-week deployment.

21. The Euro Hawk unmanned signals intelligence (SIGINT) surveillance and reconnaissance system is being developed and tested for the German MoD by EuroHawk GmbH, a joint-venture company formed by Northrop Grumman and EADS. With a wing span larger than a commercial airliner's, the Euro Hawk UAS will serve as the German Air Force's HALE SIGINT system.

22. Global Hawk has its origins in the 1995 High-Altitude Endurance Unmanned Aerial Vehicle Advanced Concept Technology Demonstrator (HAE UAV ACTD) programme initiated by the Defense Advanced Research Projects Agency (DARPA) and Defense Airborne Reconnaissance Office (DARO).

23. Global Hawk is the only unmanned aerial system (UAS) to meet the military and the Federal Administration Aviation's airworthiness standards and have approval to fly regular flights within U.S. airspace. The system is continuing its operational support having logged more than 10,000 combat flight hours with 95 percent mission effectiveness.

Future Developments

24. Major technology challenges for UAVs include: bandwidth and processing speed; air traffic control (domestically and in war zones where to minimise the potential for collisions between UAVs and manned aircraft); cooperative control of multiple UAVs by a single operator; and coordination of formations of unmanned aircraft, ground vehicles, and underwater vehicles.

25. The ability of one unmanned aircraft to operate autonomously but in conjunction with other unmanned systems may bring the greatest gain to combat forces. Technology is being developed to enable UAVs flying in formation reconfigure themselves according to mission needs.

26. Coordination among UAVs being used in theatre is critical to avoid redundancies, misinterpretation of facts on the ground, and radar interference.

27. The culmination of efforts to integrate full sense-and-avoid capabilities into UAVs will open the way for UAVs to migrate into civilian roles and applications. These will include disaster relief, crowd control, anti-terrorism surveillance, maritime search and support to the coastguard, police, fire and intelligence services.

Conclusion

28. Northrop Grumman has a 60-year history of providing more than 100,000 unmanned systems to military customers in the US and around the world, from the high-altitude, long-endurance fully autonomous Global Hawk for the US Air Force and Navy to the Fire Scout helicopter for the US Navy and Army, to the Hunter medium-altitude UAV for the US Army and the stealthy X-47B Unmanned Combat Air System (UCAS) for the US Navy capable of at-sea aircraft carrier launches and recoveries.

29. The Hunter UAV has been the workhorse unmanned aerial system for the US Army since 1996 and has more than 36,000 combat flight hours. It has been on continuous deployment in Iraq from 2003 to the present.

30. The Global Hawk UAV is currently supporting the US Air Force and has been used in border patrol missions in Iraq since 2003. It has more than 15,700 combat hours conducting intelligence, surveillance and reconnaissance missions.

31. Northrop Grumman continues to invest significantly in the UK market in providing facilities and technology to support UK Forces. We have considerable ISTAR domain expertise that we wish to bring into the UK market and can contribute by providing systems integration and interoperability expertise.

32. We are committed to bringing advanced technology into the UK defence market to accelerate the fielding of next-generation military capability and are able and willing to participate fully in helping to meet the UK's requirements in the ISTAR domain and to working with the MoD and the UK supply chain to achieve these objectives.

6 May 2008

Memorandum from the Society of British Aerospace Companies (SBAC)

1. SBAC is the UK's national trade association representing companies supplying civil air transport, aerospace defence, homeland security and space markets. Together with its regional partners, SBAC represents over 2,600 companies across the UK supply chain, assisting them in developing new business globally, facilitating innovation and competitiveness and providing regulatory services in technical standards and accreditation. SBAC's Autonomous Systems Strategy Group comprises leading UK industrialists with an interest in autonomy and engages relevant government customers and regulators with the objective of advancing the adoption of autonomy in the UK. SBAC's Autonomous Systems Network draws together the wider industrial and academic community and is intended to help develop the market and explore technologies and opportunities for the use of autonomous systems. SBAC also supports ASTRAEA, a pioneering £32 million aerospace programme addressing key technological and regulatory issues in order to open up non-segregated airspace to unmanned autonomous aircraft.

2. Autonomy and autonomous systems have been identified as having the potential to be a disruptive yet potentially beneficial technology and are an area in which companies in the UK possess leading technologies. MoD's procurement of unmanned aerial vehicles (UAVs) is currently, and is likely to continue to be a key driver of the development of autonomy technologies in the UK. Use of those capabilities by government customers other than MoD (and by implication in the domestic environment) will require that significant regulatory barriers are overcome.

3. MoD has acquired several UAV systems as Urgent Operational Requirements (UORs) for current operations. These include Desert Hawk (a mini UAV), the Hermes 450 (a tactical UAV) and Reaper (a long-range, long endurance UAV). Also, under an initiative named Project Morrigan, the HERTI system (a long endurance UAV) is being used to help the UK armed forces make informed decisions about the integration of UAV systems into the battlespace.

4. The National Audit Office has judged the performance of MoD and industry, working together to deliver UORs, to be exemplary. UORs are, quite rightly, the immediate priority but it is the view of SBAC members that MoD must be careful to ensure that it does not divert attention or investment from the task of preparing the armed forces for the different types of military operation they might face in the future. Autonomous systems have the potential to make a significant contribution to future UK military capability (in the area of ISTAR and elsewhere) and on a broader basis to support the Government's National Security Strategy and in purely civil applications.

5. The Defence Industrial Strategy recognised that "We [MoD] and industry share a close alignment of interest in UAV and UCAV technology". In this context, looking beyond immediate operational requirements, the Watchkeeper system is expected to replace the recently retired Phoenix in 2010. The DIS also made clear that "we [MoD] intend to move forward . . . with a more substantial TDP (Technology Demonstrator Programmes) designed to give us and industry a better understanding of key technologies of relevance to UAVs and UCAVs more broadly." The Taranis project has since been launched which is intended to build an unmanned fast jet demonstrator. MoD's continued commitment to development programmes such as these is essential if industry in the UK is to be best placed to provide the British armed forces with state of the art equipment in the years to come. These programmes could also have a wider relevance to security and resilience and other applications of autonomy in the UK, providing that necessary effort is devoted to resolving the airspace and other regulatory constraints on use of UAVs in the UK (eg availability of bandwidth for communications).

6. The future prospect of the opening of non-segregated airspace to unmanned autonomous aircraft is a critical factor in the development of autonomous capabilities. For UAVs to be routinely used in place of manned aircraft, particularly in the civil sector, the current regulatory framework (as defined by the Civil Aviation Authority) will need to be re-interpreted to enable UAVs to operate alongside manned aircraft. The ASTRAEA programme is intended to pave the way for the integration of UAVs into non-segregated airspace within the next decade and is currently approaching the end of its first phase. A follow-up to ASTRAEA will be necessary to ensure that this work continues; its successful conclusion is likely to have a direct impact the ability of industry in the UK to provide MoD with leading-edge autonomous technologies in the coming decades. It will also be critical if UAVs are to make a major contribution to supporting national security in the UK.

5 May 2008

Memorandum from General Dynamics UK

Summary

Providing the right information to military commanders and their political leaders, when they need it to make a decision, is a key challenge faced in all military operations. Achieving this is the task of the intelligence cycle.[11] The enterprise that is driven by and feeds into this cycle is commonly referred to as Intelligence, Surveillance, Target Acquisition and Reconnaissance—ISTAR.

Unmanned Aerial Vehicles, UAVs, are one example of the wide range of collection methods used to gather data in support of military and governmental objectives.

[11] The process that underpins the UK ISTAR enterprise is the UK's doctrinal intelligence cycle. This consists of four constituent elements: Direct, Collect, Process and Disseminate (DCPD). These are defined as follows:
Direction—the management of resources and processes to deliver actionable information and intelligence (i2) to decision makers.
Collection—the gathering of data to support answering questions.
Processing—this covers analysis and exploitation of collected sensor data to derive actionable i2.
Dissemination—delivery of the derived i2 to appropriate decision makers and end-users.

This short memorandum aims to:

(i) put UAVs into the wider context in which they operate;

(ii) summarise the importance of optimising integration of UAVs with other ISTAR assets, making the best use of the information they provide; and

(iii) give an industry view using examples of the work MoD is already undertaking to address this issue, explaining the integration capabilities that are needed to achieve planned improvements.

About General Dynamics UK

In this evidence, General Dynamics UK offers an informed industrial perspective on the challenges of integrating assets such as UAVs with the UK and its allies' wider ISTAR capabilities. As the Bowman prime contractor, General Dynamics UK has a unique expertise in digitising and integrating vital command stations together with the key communications and data networks used by all three Armed Services on operations. These include nearly 13,000 land vehicles, for example Armoured Fighting Vehicles, static land headquarters from Brigade level downwards, the Royal Navy's sea-based command centres for Royal Marine expeditionary forces, and RAF air platforms such as helicopters.

As a prime systems integrator of complex systems, General Dynamics UK has relevant expertise and capability, in particular through its key role in key UK systems integration facilities, such as the Joint Networks Integration Body, JNIB, the Joint Systems Integration Body, JSIB, and The EDGETM UK, an innovative collaborative working environment currently under development at General Dynamics UK's facilities.

The UAV in Context—an ISTAR "Collection" Asset

ISTAR can be viewed as an enterprise with definable inputs and outputs, operationally driven by the intelligence cycle. When appropriately directed by the command and control process, a range of collection assets, which can be both human and technological, collect data for subsequent processing into actionable Information and Intelligence (I2). This is disseminated to decision-makers and other end-users.

UAVs are one collection option, amongst many. Others include aircraft, submarines, satellites, ground platforms and, of course, people. Each collection option has its own strengths and weaknesses. UAVs can offer enhanced persistence and are uniquely suited to "dull, dangerous and dirty" operations. As is the case for all collection assets, the significance of their contribution to the ISTAR enterprise depends on the quality of information and intelligence they gather. The relatively recent introduction of UAVs into service in a number of nations has highlighted a wide range of specific technical and operational issues that need to be addressed to make the best use of their obvious potential.

Integrating the UK's ISTAR Assets

With the delivery of planned ISTAR collection platforms the UK will be, arguably, well provided for collection capability. The MoD rightly recognises that a priority need within UK ISTAR is improved interoperability between systems; additionally, there is a need for enhanced resource management, analysis and information management tools across the enterprise. The aim is to increase operational efficiency and flexibility. To achieve this, optimisation must be considered across the enterprise and the intelligence cycle, and not just in a single constituent area, such as collection.

If this is not done, efficiency and effectiveness will be compromised by the weakest link in the DCPD chain. Significant issues, again rightly singled out for attention by the MoD, potentially include:

— unmanageable volumes of data—much of what is collected remains unanalysed;

— lack of adequate infrastructure for getting the results of analysis to those who need that analysis

— processing timelines do not match operational needs: essentially, the right information, delivered too late, is of little or no use;

— lack of support for resource and task management: this means that the analysis work cannot necessarily be shared out between operators who are overburdened and those who have available spare capacity. This has been examined, for example, by the MoD through MEC TDP (see below);

— a limited range of exploitation tools: not all systems will allow users to see the same format, for example, ASTOR can read Ground Moving Target Data (GMTI), but cannot look at all forms of electro-optical imagery; and

— limited interoperability between systems, hindering operational integration, flexibility and operational effectiveness.

Addressing the Issues: Some Examples

It is widely recognised that improved integration across existing and planned ISTAR systems will be a key benefit deliverer. Enabling systems to "talk to each other" allows an enterprise-wide DCPD process, rather than as is currently the case, where DCPD processes taking place in parallel within different 'stovepiped' systems, for example ASTOR, Watchkeeper and Raptor.

This is a significant technical challenge. Platforms, enabling systems and networks were historically rarely procured together, and therefore not designed to "talk" to each other. It requires advanced expertise in complex systems of systems integration to overcome these challenges—experience in integrating single systems and platforms only is inadequate.

When developing a highly complex system of systems, a significant amount of specialist architectural analysis, design and integration testing of the elements is essential. This activity will be overseen within the ISTAR acquisition community by the newly formed ISTAR System Engineering Programme Organisation, ISEPO, which is intending to draw on business practices developed, *inter alia*, by the Joint Systems Integration Body (JSIB), established in 2003 as a partnership between the MoD and General Dynamics UK; the Joint Networks Integration Body (JNIB), which de-risks network "end-to-end" communications capabilities; and the Modular Exploitation Capability (MEC) Technology Demonstrator Programme (TDP).

MEC TDP—completed in 2006—was a highly successful technology demonstration programme to show how individual ISTAR legacy systems could be brought together into an integrated exploitation system of systems. Additionally, it demonstrated how intelligence analyst resources could be managed across the system of systems. MEC TDP was sponsored by DEC(ISTAR) and managed by the Future Business Group. It is anticipated that a capability with these attributes will be sought within the early tranches of DABINETT.

Future Programmes

In recognition of the gaps that currently exist, the MoD plans to invest significant funds in the DABINETT programme. DABINETT aims to address these identified gaps by delivering an enterprise-wide system of systems, with associated process change across all the Defence Lines of Development (DLoD) and with the necessary connectivity and interoperability with UK government agencies and allies. Subject to Planning Round 08, the first individual projects within the DABINETT programme are expected to get underway within the next 12 months.

The defence budget is under significant pressure. This poses a significant risk to smaller enabling projects, designed to connect up systems and deliver operational flexibility, agility, and other benefits of Network Enabled Capability. These projects deliver benefits out of all proportion to their cost. For example, the £50m project LISTENER aimed to automate data sharing between collector platforms in order to ensure timely identification and tracking of high priority targets. This would have allowed decision-makers to deliver timely engagement of fleeting targets. However, its Demonstration and Manufacture phase has been cancelled in the current MoD planning round. The need to integrate ISTAR platforms and systems is rightly recognised, and any tendency to cut such programmes in favour of larger and more visible platform procurements should be resisted if the benefits of a functioning ISTAR capability are to be delivered to the forces on the front line.

Starkly, it is no use collecting data without the means to fuse it into a timely and coherent picture so that decision-makers can act upon it. This is a key tenet of NEC. Fusion/NEC appears to be an ISTAR capability gap. With the cancellation of LISTENER, which would have done it for airborne EW, one has to question whether the MoD is giving fusion/NEC sufficient priority.

12 May 2008

Memorandum from Finmeccanica UK

Scope

1. This memorandum is intended to add the Committee's body of evidence by highlighting the contribution of Research and Technology in three of the issues under consideration:

- Optimising the "Collect, Process and Disseminate" phases of the ISTAR chain.
- The way in which future UAS[12] capability is informing the MOD's overall approach and direction relating to ISTAR.
- The airspace and air traffic control implications for the wider operation of UAS.

[12] The term UAS is used generically to include the platforms, mission systems, sensors and personnel engaged in the "Direct—Collect—Process—Disseminate" ISTAR chain, more properly termed an Unmanned Air System (UAS).

To address these issues, this memorandum covers: the context for ISTAR in the future battlespace; sensor developments related to operational effectiveness and "sense and avoid"; integration of the UAS ISTAR product through common ground control stations; and the implications for autonomous operations.

UAS in Finmeccanica

2. In terms of UAS platforms and sensors, Finmeccanica with its constituent companies, covers the entire spectrum of development programmes. The Alenia Aeronautica Sky-X is a large UCAV technology demonstrator programme while the Sky-Y is a diesel-engined Medium Altitude Long Endurance UAS designed to explore autonomous operation. The Company's Nibbio fast reconnaissance UAS has a cruise speed of 0.85 Mach and high survivability given its low radar cross-section and defensive aids suite. They are also collaborators in the European Neuron stealthy, autonomous UCAV programme with a 22% share. SELEX Galileo manufactures the Falco tactical UAS, currently in service with the Armed Forces of a Middle Eastern country. SELEX Galileo is also collaborating with a number of UK and Italian SMEs to develop a range of mini-UAS. Of the current family of five platforms which embrace a number of novel aerodynamic and propulsion technologies, the STRIX UAS is currently in service with a NATO member country.

3. As for sensor payloads, SELEX Galileo design, develop and manufacture radar and electro-optical sensors, and defensive aids suites for fixed and rotary wing aircraft, armoured fighting vehicles and ships. They also have expertise in Command and Control, and mission systems. The underpinning technologies have also been developed for UAS applications. In terms of integration and training, AgustaWestland have expertise in the integration of platforms and weapon systems into the land battlespace, based on their Bowman and Apache integration, mission planning/de-briefing and training contracts. Equally, the development of Future Lynx multi-spectrum sensor integration, tactical processing, data fusion, target handling, Command and Control, and weapons and communications integration has contributed to this key industrial capability. AgustaWestland has also completed live flying trials for launch and recovery of small UAS and loitering munitions from helicopter weapon pylons. With the move towards Unmanned Ground Vehicles (UGV) and Unmanned Underwater Vehicles (UUV), the concept of deploying, controlling and recovering UGV and UUV from helicopters should not be overlooked. AgustaWestland also has proven experience in packaging, transporting, and the deployment and recovery of assets of this scale in the EH101 family. AgustaWestland continues to work with Boeing and the US Army's Program Executive Office for Aviation to assess current work on Apache AH64-D for manned and unmanned platform integration. The Company will provide the capability development path for any consequent changes to UK WAH-64D as the technology and requirement matures. Taken together, this expertise underpins Finmeccanica's experience and capabilities on the integration and connectivity between land, maritime and air systems (including UAS) in association with future land and maritime operational concepts, not least the UK's aspirations on Land Medium Weight Capability.

Future Context

4. From the war-fighter's perspective, the development of ISTAR capability is complicated by two factors. First, the Committee has been made aware of the need for robust information management capability in an increasingly networked world so as to optimise the "Direct—Collect—Process—Disseminate" ISTAR activity cycle. Secondly, as we look to the next decade, this activity cycle is further complicated by the existence of increasing numbers of non-traditional or multi-role ISTAR collectors that might be involved in an entirely different primary mission. Fast-jet attack aircraft continually generate ISTAR data from their targeting pods and EW systems. A current example is the integration under a UOR of the Lockheed Martin Sniper pod, which itself contains SELEX Galileo technology, onto the UK Harriers operating in Afghanistan which provide both direct and indirect ISTAR data. In addition, the ISTAR requirements for some missions cannot be centrally managed regardless of the capacity and agility of the connecting network. Rather, they have to be held as organic both to the platform and to the fighting formation concerned. The Committee will be aware of the insatiable demand for video imagery among our forces in Afghanistan. Systems such as the ROVER ground terminals are employed to provide this capability but future requirements will outstrip the data-handling capacity available. In addition, multi-role platforms such as Future Lynx become vital assets in the type of high-intensity manoeuvre and counter-insurgency warfare envisaged in the future. Here, the related reconnaissance task includes the movement and support of recce, observation post, and Joint Fire control parties of four men and their equipment in the battlespace. The maintenance of tempo requires commanders to move such elements rapidly to plug gaps in ground reconnaissance, move recce/fire control parties over difficult terrain and to react quickly by calling-in firepower, hence the selection of a single, multi-role platform to facilitate all these tasks.

5. Conceptually, in these types of scenarios, the ISTAR chain will need to be seen as being subsumed by the Kill Chain[13] but with a "person-in-the-loop" at every stage. While this potentially places a limitation on the degree to which both UAS and UCAS will be able to substitute for manned systems, it also highlights that the future context will require a balance between manned and unmanned systems with integration and

[13] Find—Fix—Track—Target—Engage—Assess.

interoperability being paramount. More broadly, apart from the question of what unmanned vehicles could achieve, the existing ISTAR and command and control contributions from manned rotary platforms remains far from exploited. The question of "what" and "how" these contributions could be tapped into and for what resource cost needs to be addressed by the appropriate MOD Capability Planning Group. AgustaWestland would be well placed to lead the industrial support to a properly tested response, backed-up with technical and architectural audit through NITEworks.

6. As the Committee knows, MoD has initiated a UAS Capability Investigation which has been subdivided into six working groups. They are: Acquisition Coherence; CONEMP/CONUSE; Integration Standardization and Interoperability; Requirements Development; R&D; and, Training and Employment. SELEX Galileo is represented on three of these working groups including the Integration Standardization and Interoperability group. The output of this effort, expected later this year, will influence the future integration of UAS into the overall ISTAR environment.

Sensor Developments

7. Most UAS ISTAR payloads are currently restricted to Electro-Optical and Infra-red (EO/IR) sensors. The next step is to include a Synthetic Aperture Radar (SAR) with more advanced EO/IR sensors that are capable of mutually cueing each other. Such a capability is not only required for effective ISTAR collection but is also on the pathway towards autonomy. SELEX Galileo is active in the development of such payloads for tactical UAS and their larger counterparts. However, in all cases weight, space, power and cooling capacity places a high premium on miniaturisation. To this end, the company's PicoSAR radar is the result of a £5 million PV programme and makes full use of "commercial, off-the-shelf" technology. It is an advanced electronically scanned, briefcase-sized, lightweight (less that 10 kilograms) radar system offering high resolution Synthetic Aperture Radar (SAR) and Ground Moving Target Indicator (GMTI) imagery with low power consumption (less that 300 watts). It has been successfully trialled by the US Army. It has recently demonstrated an effective "coherent change detection" capability which may prove a valuable aid in locating IEDs. The PicoSAR rests on the bedrock of SELEX Galileo's broader electronically scanned radar technology which includes both airborne search and fire control radars which are either fitted on or intended for the US Coastguard C130 and Citation aircraft, Typhoon, Tornado and the Korean Aircraft Industry A-50. In both the DIS and the DTS, this technology was regarded as one over which the UK wished to retain operational sovereignty and maintain on-shore intellectual property.

8. As for the development of UAS EO/IR capability, SELEX Galileo has a long-established capability in laser targeting systems. The company's PicoBIL is a £8 million PV programme which uses gated, burst illumination laser technology to provide 3-D target-quality images. Again, miniaturisation has been the key so as to reduce weight and space requirements and allow maximum UAS endurance. The technology is now sufficiently mature to allow SELEX Galileo to offer a burst illumination upgrade package to current generation EO turrets and targeting pods. The laser technology is derived from that contained in the Sniper reconnaissance pod which is currently flying on RAF Harriers in Afghanistan. Lockheed Martin selected SELEX Galileo as the laser supplier for Sniper and for the more advanced targeting sensors in JSF: Northrop Grumman selected SELEX Galileo as the laser supplier for the Litening pod. Again this world-class technology was recognised in the DIS and DTS as being a required on-shore capability. Work is now in train to integrate and demonstrate PicoSAR and PicoBIL as a single UAS payload so that the radar can act as the search aid for ISTAR targets of interest and cue the laser for more granular analysis, including target recognition. In addition, other classified programmes will see the integration of other Electronic Warfare ISTAR capabilities into integrated UAS payloads.

9. Electronically-scanned radar and Electro Optics are very important technologies to the Defence Industry. As the DIS recognised, in the future, platforms will remain in service for prolonged periods. As a result, incremental capability enhancements in key areas such as self-protection, situational awareness and fire-power will be generated from sensors, software and mission systems embracing these same technologies which have applicability in the fixed-wing, rotary, land and UAS domain. As a result and given the MOD's resource difficulties, the Department will need to think creatively over how to nurture the development of these technologies and provide the incentive to industry to retain the intellectual property in the UK. Thus, in seeking to buy 'off the shelf' from other nations (particularly the US), they will need to consider the impact on existing on-shore capability and the implications for operational sovereignty.

Common Ground Control Stations

10. In terms of the integration of UAS into the ISTAR mix, there are operational, logistic and training advantages in seeking to create a common ground control station (CGCS). To this end, SELEX Galileo has funded a research programme to design and demonstrate potential architectures. The resulting CGCS will be built and installed at the Company's UAS trials facility at ParcAberporth and integrated with the Concept to Capability (C2C) synthetic environment developed by our Luton facility. The CGCS will be compliant with both the NATO and US standards for platform control, imagery and data. The C2C can then integrate the real-world CGCS and UAS within its synthetic environment enabling development and

test of multiple architectures for command and control, mission management, weapons release and autonomy in as realistic an environment as possible. This arrangement will be a vital tool in helping to develop the UK's approach to Network Enabled Capability.

Autonomous Operations

11. In future, the autonomous operation of UAS will be required for three reasons. First, as the number of network-enabled systems of all types grows, so will the pressures on communications bandwidth. Autonomy reduces the high datalink requirement inherent in the remote operation of UAS and also means that the opposition's battlefield jamming is less effective. Secondly, the very short decision-action times required in some operational environments, particularly against fleeting asymmetric targets, will require autonomous operation. In addition, as threat levels to conventional platforms increase in the future, 'first day of war' capabilities will require a mix of manned stealth aircraft and 'swarms' of UCAS in a single force package. Equally, swarms of UCAVs will be required to overwhelm defences. Finally, safe operation of civil and military UAS alongside manned aircraft in non-segregated UK (and international) airspace is deemed to require a "sense and avoid" capability from UAS in order to comply with the Air Navigation Order. However, the term "sense and avoid" underplays the complexity of the problem. Rather, the required capability is better described as "Detect, Identify, Decide and Manoeuvre" which autonomy will provide.

12. Early next year, SELEX Galileo will site a Falco UAS at ParcAberporth for test, trial and demonstration of various types of payload. Included within that programme, we also plan to trial various potential technologies for "sense and avoid" capability. We expect a proportion of these trials to be in cooperation with ASTREA. Falco will be flown from the CGCS which in turn will be integrated within the synthetic environment of the C2C. This will allow us to test in a real world environment multiple scenarios for assessing various autonomous flight solutions.

21 May 2008

Memorandum from L-3 Communications UK

L-3 Communications UK Ltd is pleased to submit evidence to the House of Commons Defence Select Committee as part of its inquiry into ISTAR and the role of UAVs.

Headquartered in New York, L-3 Communications is an international defence company employing over 64,000 people worldwide and is a prime systems contractor in aircraft modernisation and maintenance, C3ISR (Command, Control, Communications, Intelligence, Surveillance and Reconnaissance), Systems and Government Services. L-3 Communications is also a leading provider of high technology products, subsystems and systems.

L-3 Communications has a proud history of cooperation and success with the Royal Air Force in airborne intelligence, surveillance, target acquisition and reconnaissance capabilities. The company was recently selected by the MoD as the preferred bidder for Projects HELIX, IBS (Integrated Broadcast System) and LISTENER. All of these are key programmes at the centre of the UK's future ISTAR capability. L-3 Communications has a growing presence in the United Kingdom with sites across the UK at Tewkesbury, Bristol, Barrow, Burgess Hill, Alton and Bracknell.

The demand for situational awareness, force protection and operational overwatch in Iraq and Afghanistan is fueling the demand for Full Motion Video and UAVs are transforming UK forces' ability to deliver this information to the front line commands. In addition, weaponised UAVs are enabling commanders to shorten the "kill chain", thus allowing the current, asymmetric fleeting target to be attacked. Furthermore, in counter-insurgency operations, where the coalition has air supremacy, UAVs can range across the entire area of operation, with their relatively small field of view sensors providing tactical support to front line forces.

A key feature of UAVs is the Tactical Datalinks that provide the specialised information infrastructures. These underpin low latency shared situational awareness and command and control, enabling the prosecution of "difficult, fleeting targets" by providing for the near-real time exchange of information. Current operations have shown that the critical information requirement throughout the Find, Fix and Finish spectrum of operations is the dissemination of Full Motion Video to both headquarters and front line troops.

Traditionally, new platforms and sensors have provided an attendant downlink and viewing device, leading inevitably to a growing logistic burden as the scale of operations, enemy behaviour and our burgeoning "Find" Capability has led to an increase in platforms such as UAVs. In order to resolve the operational and logistic burden of servicing multiple FMV feeds, the L-3 CSW ROVER has been developed as a "One Solution Remote Viewing Terminal" offering the operator a wide-band, multiple frequency device for viewing the Full Motion Video output of the majority of the Joint and Combined deployed ISTAR sensors and targeting pods.

The future ROVERs will be characterised by high capacity, improved security, joint and multi-national interoperability and a greater spread of capability—not just in the land mounted and dismounted roles but in fixed and rotary wing and maritime platforms, as well as NATO and coalition partners. The linked exploitation of Tactical Datalinks will be a key operational transformational factor and will provide the backbone of information dissemination for the foreseeable future, cementing the UAVs role in the "find" constellation. Over time, this growing Tactical Data Link capability will lead to the evolution of Remote Viewing Terminals into core elements of C4I infrastructures. FMV will become as common as today's command and control tool, the Map and Voice Combat Net Radio.

Turning to the constraints in the current generation of UAVs, on particular operational missions a vital element in the derivation of an opponent's intent is provided by the collection, fusion and dissemination of signals in the electromagnetic spectrum. With over 40 years' experience in the provision of manned assets in the electronic surveillance domain, L-3/Integrated Systems plays a key role in providing strategic, theatre and tactical support to both US and UK war fighters. One of the key elements that must be understood is the impact of the laws of physics in addressing the technically sophisticated, as well as the simple radio frequency targets in today's complex and challenging environment. Indeed, the challenge today is no longer finding the needle in a haystack, it is finding the right needle in a stack of needles.

Studies in both the US and UK have identified that a mix of capabilities, both manned and unmanned, is required in the future for successful operations across the spectrum of conflict and in the range of scenarios in which UK and US forces are and could be engaged.

Unless networked together, the laws of physics intervene and the sensor capability of the current generation of UAVs is unable to deliver the required accuracy or the sensitivity to prosecute the modern target set. (Singular, fleeting targets require more accuracy and more accuracy requires either more platforms/sensors or networked sensors to cover more of the electro-magnetic spectrum from more angles to quickly resolve the target position). In order, therefore, to achieve the geolocation of a target emitter to the accuracy that modern operations demand, a broader, networked capability is required.

This capability can currently be best derived from a large airliner-sized asset with the ability to carry a large array, networked to the smaller sensor platforms, with the computing power to fuse the data collected and then to report to the wider community the intelligence and information derived.

In future, the types of targets that UAVs can prosecute will increase, thus increasing their tactical value and driving the requirement for the dissemination of Full Motion Video yet further. A force mix of the large manned platform, however, which acts as the host for off-board processing of UAV collected data connected to the capabilities that are resident in the space segment, offers the optimum mix of assets to successfully prosecute and derive the required intelligence.

This balance will allow UK forces to achieve greater shared situational understanding and to underpin the improved decision support UK commanders need in today's and tomorrow's complex battlespace.

30 May 2008

Further supplementary memorandum from the Ministry of Defence

(i) *The latest position regarding the deficit in UAV operators in the Army (and the Royal Navy and RAF if deficits also exist) (Q 21)*

The Army's UAV operators are provided by 32 Regiment Royal Artillery.[14] The state of manning at any one time only provides a snapshot of a naturally fluid picture. At present, there is a recognised shortfall among trained senior UAV tradesmen (NCOs). Against the previous Phoenix-based establishment, the shortfall of trained senior operators was around 38%. These individuals do not necessarily operate the UAV directly but are responsible for managing their operation. For current operations, using the Hermes 450 system, there is currently no shortfall of qualified personnel (helped partly by the reduced demand for senior operators). The manning establishment of the Regiment has recently been increased in preparation for the entry into service of the Watchkeeper UAV system which is planned to begin towards the end of 2010. If measured against this new establishment, the senior operator shortfall based on current manning levels would be around 70%. Over the next two years the Army will address this situation through normal manning processes, such as extra training courses and transferring personnel from trades where manning levels have been reduced to ensure that the new establishment is met. This is not an unusual situation as an establishment must be changed before extra personnel can be posted to a unit. If necessary, a range of extra measures, including Financial Retention Incentives (FRI), may be used to aid in recruitment and retention (FRI for qualified UAV operators employed in 2007–08 was very successful; it achieved 100% take up rate and guaranteed a three year return of service).

[14] Currently, 47 Regiment Royal Artillery is being temporarily re-roled, a battery at a time dependent on the operational requirement, from close air defence to operate the Desert Hawk mini UAV on current operations.

RAF manning for UAV operations is currently broadly in balance. There is no current requirement for UAV operators in the Royal Navy.[15]

Overall, there is sufficient trained manpower to meet current operational requirements, albeit this has required, as elsewhere, a rebalancing of priorities and breaking harmony guidelines for some individuals.

(ii) *Which branches of the Army personnel have transferred from to become UAV operators (Q 22)*

Personnel from a broad range of other arms and trades across the Army have transferred into the UAV operator trade, moving in at the appropriate level. There has been no particular preponderance of any one arm or trade.

(iii) *The latest position regarding deficits in analysts (in each of the three Services) and the initiatives in place to address the deficits (Qq 32–35)*

The increased use of Full Motion Video (FMV) and the introduction of new collection assets mean that the requirement for analysis across Defence is increasing. This has a consequential effect on the quantity and type of analysts needed. The shift in emphasis is being taken into account in, for example, the reprioritisation of work.

There is currently a shortfall of around 18% in imagery analysts within the RAF and in the short term this is being addressed through management of training, including the introduction of a new basic course on FMV. For the longer term, the position will continue to be monitored and the Department is developing an overall strategy to make better use of this scarce resource, including work to understand better the recruitment and retention issues and whether the training course structure is right. A recruitment strategy is already being implemented although owing to the training profile this is not expected to provide additional image analysts for around two years. Manning in the other Services is broadly in balance.

Overall, there is sufficient trained manpower (with use of reserves) to meet current operational requirements but, as in other areas there has been a need to rebalance priorities.

(iv) *The difference between a restricted area (temporary) and a temporary segregated airspace (Qq 81–82)*

The definitions of a "Restricted Area (Temporary)" and "Temporary Segregated Airspace"are given below:

Restricted Area (Temporary). A Restricted Area is airspace of defined dimensions within which the flight of aircraft is restricted in accordance with certain specified conditions. Restricted Areas established under the regulations contained in the Air Navigation Order may be temporary or permanent; in case of temporary airspace they are designated as Restricted Area (Temporary) or RA(T).

Temporary Segregated Airspace (TSA). TSA is airspace of defined dimensions which is reserved for the exclusive use of specific users during a determined period of time. TSAs were envisaged as being part of the flexible use of airspace (FUA) concept. However, the full introduction of this will be delayed until International Civil Aviation Organisation (ICAO) and European Civil Aviation Community (ECAC) terminology have been aligned. Proposals for the ICAO definition of TSA include the statement "through which other traffic will not be allowed to transit", which effectively removes the flexibility of allowing operators to 'share' the airspace when other planned activities are not taking place. There is currently no existing definition for 'segregated airspace' within EUROCONTROL or ICAO.

Comparison of these definitions indicates that the differences are:

- A RA(T) is an extant CAA regulation that is in use today, but a TSA is a new regulation that has yet to be implemented.
- A RA(T) allows aircraft of all types to use the airspace in accordance with the specified conditions, whereas TSA reserves the airspace for the exclusive use of a certain user.

(v) *Details of who is responsible if a UAV falls out of the sky and causes injury or death (Qq 89–91)*

When compensation claims are received they are considered on the basis of whether or not the Ministry of Defence has a legal liability to pay compensation. Where there is a proven legal liability, compensation is paid. It therefore follows that the Ministry of Defence would compensate anyone suffering a loss in the event of a UAV accident that was caused by the Department's negligence.

2 June 2008

[15] The Royal Navy has provided operating personnel as part of the UK contribution to US-UK Combined Joint PREDATOR Task Force.

Printed in the United Kingdom by The Stationery Office Limited
8/2008 399532 19585