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Defence Research and Development in the Atlantic Nations

A RUSI European Security Programme Study

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Executive Summary

Most Research and Development (R&D) in the world is funded by the private sector and is impelled by the need for competitive advantage in the market place. But it has long been recognized that market imperfections are unlikely to provide all the R&D needed in sectors such as defence and public health, and in long-term ('far from market') research of all kinds. In these and similar areas, there is a well established acceptance on both sides of the Atlantic that governments will provide much of the funding, and this makes possible the conduct of international collaborative research programmes mediated by governments, if they see it in their joint national interests to arrange them.

In the case of defence R&D, the arguments for such collaboration are different on the two sides of the Atlantic. For the European nations, their individual national defence R&D budgets are only around one-tenth of those of the US (which sets the benchmark for military capability derived from technology) or less. Collaboration either within Europe or across the Atlantic is therefore a necessity because of scale.

For the US the arguments are different. First, the changing nature of the threats faced by the Western democracies requires new military technologies as well as further developments of old ones. In the US and across the world, military R&D is only a small part of total R&D, and the new technologies are thought increasingly likely to spring from origins outside the defence sector. Moreover, even the totality of all R&D in the US is less than half of all that in the entire world. A world view of technology is therefore needed, and collaborative activities can help achieve this. Second, the quality of non-defence R&D, as measured by bibliometric and related indicators, is higher on average in certain small- and medium-sized countries (including the UK) than in the US. Finally, the US needs to form alliances to confront the threats facing it effectively, and at present only the UK and France, among the G7 nations, have the political will and substantial military means to play leading roles in such alliances. Leading allies need equipment of comparable technological power to that of the US, and to be interoperable with it. Such technological power can be expected to derive in part from equipment purchases from the US, but it is unrealistic to assume that all will come from this source. Collaborative programmes, based upon collaborative R&D are therefore needed, and the F-35 Joint Strike Fighter is a prime current example.

However, the F-35 has shown the weakness of present arrangements. The UK, the leading collaborator with the US, has had increasing and increasingly public difficulties in collaboration with the US, because of the restrictions placed on all US technology transfers to other countries (even of unclassified technology) by the International Trade in Arms Regulations (ITAR).

ITAR is the biggest obstacle to trans-Atlantic R&D collaboration in the defence field, and possibly in other fields as well.

The failure of Congress to approve an ITAR waiver for the UK has led to a provisional treaty between the US and the UK which, subject to Senate approval, could avoid ITAR - at the price of making classified (for UK

purposes) all material received from the US. While this may solve the problem in respect of well-defined projects such as F-35, where the end product and its ownership are clear, it is less certain whether it will work well for earlier stages in the R&D process. In particular, basic and applied research – where it is in the nature of the activity that one piece of research leads to another, and one stream of research merges with others or splits into several streams – seems likely to present difficulties to the treaty concept that any piece of technology transferred from the US will remain under US control in respect of transfer beyond the UK, both in its original and its derivative forms.

Finding a way for the treaty to work well in respect of research, as opposed to equipment projects, seems likely to be challenging.

However, some research generally avoids the constraints of ITAR. By a Presidential Directive of 1985 that still operates, Basic Research ('6.1 Research' in US Department of Defense (DoD) terms) is generally exempt from ITAR. This constitutes more than a quarter of US defence research, and might be expected to provide a particularly attractive field for trans-Atlantic collaborative projects. It is therefore remarkable that neither the UK nor France shows any expenditure in this category in its official figures for defence R&D. That this is not simply a bureaucratic error is shown by interviews we conducted with the offices of the three US armed services in London, which are charged with seeking out new technologies at the Basic Research level, which are of potential significance for generating technology to support military capabilities in the future. They find no lack of such technology in the UK and across Europe, and contribute money to appropriate programmes to gain access and insight. Some of the research they fund in the UK also attracts funding from the UK government, but as far as they could tell (with one single exception of recent origin), none of this funding came from the UK Ministry of Defence (MoD), and none was subject to a collaborative research agreement between the UK MoD and the US.

Given that the nature of the threats facing the western nations is changing in radical ways, as symmetric opposition is replaced by asymmetry, new defence technologies will be required that are derived from new Basic Research. This is as true for the UK, France and the other European nations as it is for the US. This, together with the 'ITAR free' nature of Basic Research collaboration, makes the UK and French failure to invest in Basic Research disturbing.

The failure of the UK and France to invest in Basic Research with potential to generate new military capabilities to meet the new threats, and their failure to seek mutually beneficial leverage from the large US investment in this area, is the biggest obstacle to trans-Atlantic defence research collaboration on the European side of the Atlantic.

Defence Research and Development in the Atlantic Nations

Introduction

The importance of science and engineering research and development for wealth creation, improving the quality of life and protecting the environment is undisputed. Globally, expenditure on R&D continues to rise, both in absolute terms and as a percentage of GDP.[1] But nations struggle to afford this increased expenditure, as longer term R&D investment competes with short-term profitability in the private sector, and with other government priorities in the public sector.[2] Any legitimate means to improve the efficiency of R&D expenditure must therefore improve human wellbeing at the global level by increasing the R&D that can be afforded for the money available.

One way to improve efficiency is by promoting international collaboration on R&D funding, but this immediately encounters two opposing forces. The first is that wealth creation mostly relies on market mechanisms for its internal organization and so is competitive. Firms usually see investment in R&D as a means to achieve competitive advantage and will only carry out R&D in partnership with other firms under limited sets of circumstances. Even when enhancing the quality of life or protecting the environment is the ultimate aim, market mechanisms are often harnessed to these aims, thus restricting the scope for substituting collaboration for competition (pharmaceuticals is an example[3]).

The second difficulty is that the outcome of scientific and engineering research is by its nature unknown and uncertain of success. Tackling the same problem several times over may be the best way of getting to the best solution – a kind of market competition in original thinking. Nevertheless, the selection of some research proposals in preference to others is a fact of life for all researchers and all funding agencies, and applied with discretion, collaboration can provide a useful means to make limited research funds go further.

The purpose of this study is to look again at some areas where international collaboration in defence R&D funding has a role to play at the government level, and see if there is scope for improvement. In particular, the study will examine transatlantic collaboration, focussing on the UK and France on the European side, because of the similar expeditionary philosophies and capability requirements the three countries share in the defence domain. However, other major countries in R&D terms will be considered as appropriate.

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[1] Evolution of gross domestic expenditure on R&D (1995-2003), Trends in domestic R&D expenditure (A.2), R&D and Innovation: creating and diffusing knowledge (A), *OECD Science, Technology and Industry Scoreboard 2005 - Towards a knowledge-based economy*

[2] The US is just one example of a country faced with such a challenge. National Science Foundation's Division of Science Resources Statistics, 'Chapter 4: Research and Development: Funds and Technology Linkages', in *Science and Engineering Indicators* (2006), p. 4.8-4.9

[3] In 2003 the UK pharmaceuticals sector spent about £3.2bn on R&D, compared to total government funded R&D in the medical, health and biological sciences areas of £1.2bn.
UK Department of Trade and Industry SET, *Statistics October 2005*, <http://www.dti.gov.uk/science/science-funding/set-stats/index.html>

The study addresses defence R&D in the Atlantic nations, examines the advantages of and difficulties in collaborative defence R&D and makes a number of recommendations.

The Role of Government in Research and Development Funding

The role of government in funding R&D, in particular sectors of the economy, was first mapped out comprehensively in the US in 1945 by the then head of the US Office of Scientific R&D, who identified Defence, Medicine, Public Health, Agriculture, Housing and Capital Intensive Research as being unlikely to receive sufficient funding from private sources alone, and hence requiring continuing public support.[4] The economic case for such continuing state intervention was formalized more than ten years later, on the basis that private sector institutions would be unable to gain sufficient exclusivity to the exploitation of advances in these areas to be able to recoup the necessary investment in R&D.[5,6] In general, economists recognize that private markets can fail to function as intended due to imperfections and externalities and R&D is an instance of externality that demands state intervention. In the particular area of defence, government sponsorship of R&D was firmly established before the Bush report, with UK defence R&D establishments in existence well before the Second World War.[7]

Running, as it were, at right angles to these 'special sectors', is a second domain of government support: basic scientific research, which is too far from having a clearly foreseeable commercial application, both in terms of time and clarity of view of the end point, for commercial funding to be feasible. In the words of one author of groundbreaking papers on international research benchmarking, 'Governments are the principal funders of basic research because the results are unforeseeable and unknowable'.[8] This area is sometimes also called 'far from market research', and the formal economic justification for its continuing support by government depends on essentially the same arguments as those for the support of R&D in the 'special sectors'. Historically, government support for basic research also predates that for the 'special sectors'. In the UK, a Department of Scientific and Industrial Research was established well before the Second World War – electronics developed under its sponsorship subsequently found new wartime applications in the earliest radar sets.[9]

By focusing on defence R&D and on Basic Research within it, this paper directs itself to a place where the two strands of government support for R&D cross. However, to complete the rationale for its scope, we must also consider the case for inter-governmental collaboration in these areas, and this is the subject of the next section. Of

[4] Vannevar Bush, *Science—The Endless Frontier,* Report by the Director of the US Office of Scientific Research and Development (1945)

[5] R Nelson, 'The simple economics of basic scientific research', in *Journal of Political Economy* (49, 1959), pp 297-306

[6] K J Arrow 'Economic welfare and the allocation of resources for invention' in R Nelson (ed), *The Rate and Direction of Inventive Activity* (Princeton , NJ: Princeton University Press), pp 609-25

[7] G Hartcup, *The Effect of Science on the Second World War* (London: MacMillan Press Ltd, 2000) p. 3

[8] Robert M May, 'Scientific Investments of Nations', in *Science* (No. 5373, Vol. 281, 1998) p. 49

[9] G Hartcup, *The Effect of Science on the Second World War* (London: MacMillan Press Ltd, 2000), p.3

course, defence Basic Research is not the only category of such research that lies at this crossing point of the strands of government support - Basic Research in medicine is another example but this study will limit itself to the defence arena.

Why International Collaboration?

Among governments who expect to face major challenges to their security in alliance with one another, pooling resources so as to maximize the technological advantage that the alliance has over potential opponents, maximizes the security of all. This was the basis on which the UK and US governments pooled resources on topics such as radar, cryptanalysis and nuclear weapons in World War II, and have continued significant R&D collaboration since.

However, in times of less extreme emergency, two powerful counter-arguments run in opposition to this 'pooled resources' argument. The first of these goes right back to the days of the US Office of Scientific R&D report referred to earlier. The report was commissioned by a letter from President Roosevelt, which referred explicitly to '….the creation of new enterprises bringing new jobs, and the betterment of the national standard of living'.[10] All nations that spend significant sums on defence R&D see the investment not only as a source of increased national security, but also as conferring advantage on their industry and economy over those of allies as well as potential rivals. Overcoming this barrier requires a carefully negotiated agreement, finely balancing costs and benefits, so that the defence industries and legislators with interests can see that there is a net commercial and economic benefit (as well as a security benefit) from international collaboration.

Unsurprisingly, negotiating such agreements gets harder as the R&D moves through the Frascati[11] phases of Basic Research, Applied Research and Experimental Development, and as the R&D gets closer to producing a marketable product. The results of a study of defence equipment acquisition by the UK National Audit Office, found that (for the UK) more international co-operative programmes exist in the early stages of R&D, than in the later R&D and production stages combined.[12] This is despite the fact that (as we shall see later) nations individually spend far more on the later stages of R&D than on the early stages; and they spend much more still on production.[13]

The history of UK and US collaboration on the F-35 Joint Strike Fighter (JSF) illustrates the difficulty of negotiating agreements acceptable to all parties, including industry and legislators as well as both governments, in the late stages of R&D (well into Experimental Development, in Frascati terms). A key issue was whether the UK would have sufficient access to technical data about parts of the aircraft on which R&D had been done in the US, to be able to use the aircraft independently of the US

[10] Franklin Delano Roosevelt, *Letter to Vannevar Bush*, 17 November 1959, Washington, DC. <http://www.nsf.gov/about/history/vbush1945.htm#letter>, accessed April 2005

[11] OECD, *Measurement of Scientific and Technological Activities: Frascati Manual 2002 - Proposed Standard Practice for Surveys on Research and Experimental Development*

[12] *Maximising the Benefits of Defence Equipment Co-operation*, Report by the Comptroller and Auditor General (HC 300 Session 2000-2001: 16 March 2001) figure 2, page 8

[13] The reason more is spent in these latter stages is because the majority of costs always fall within them. Report by the Comptroller and Auditor General, *op. cit.* figure 3, page 8

government and support from US contractors. The term 'appropriate sovereignty' was coined to describe the imperative for access to such data, and the general problem was set out in the following terms within a UK government White Paper in late 2005:

> "To meet our own sovereign needs, it is important that we continue to have the autonomous capability to operate, support and where necessary adapt the equipment that we procure. Appropriate technology transfer is therefore of crucial importance…. In practice difficulties have arisen particularly with the US…. This is not about gaining competitive advantage for UK industry, it is about being confident that the equipment we buy meets the capability requirements…. and can be modified to meet emerging requirements through life. We fully recognize the need to ensure that intellectual property is protected….[14]"

In March 2006 the UK Minister responsible set out the arguments to the Senate Armed Services Committee in the context of the JSF project,[15] but reports of difficulties continued. It was not until the agreement was signed between the two governments in December 2006, to proceed jointly on the next phase of R&D, that the matter was resolved, and then, apparently, only on the basis of 'assurances' rather than text within the main agreement.[16]

The difficulties experienced in the JSF programme are symptomatic of wider problems in US-UK defence technology co-operation. In November 2005, it became clear that opposition from Congress to Britain's bid to secure exemptions from restrictive US export controls (imposed by the International Traffic in Arms Regulations (ITAR)) could not be overcome.[17] . In a 2004 report by the House International Relations Committee, British defence export regulations were criticized as 'not only disappointing, but potentially highly prejudicial to US interests around the world'[18]. Such congressional fears crystallized around the concern that technologies sold to or shared with the UK might end up in Chinese hands. [19] The failure to grant the UK an ITAR waiver has been something of a thorn in transatlantic relations ever since. While some allege that this was simple industrial protectionism on the part of Congress, an ITAR waiver would, as well as greatly simplifying British access to the American market, also help further open the UK market to US defence industry. As a result, much of US industry supported the UK bid for an ITAR waiver and it was widely championed among defence policy officials and armed forces personnel, for whom the US defence export regime greatly complicates efforts to ensure the

[14] 'Technology Sharing Across the Atlantic', in *Defence Industrial Strategy*, UK Government White Paper, Cm 6697 (December 2005), p. 45

[15] Lord Drayson, meeting with Senate Armed Services Committee, 14 March 2006 <http://www.mod.uk/DefenceInternet/DefenceNews/DefencePolicyAndBusiness/LordDraysonJsfOperationalSovereigntyIsVitalForUkDefenceInterests.htm>

[16] Minister of State for Defence Procurement, Lord Drayson, meeting with US Deputy Secretary of Defence, Gordon England, 12 December 2006. 'UK signs up for next phase of the Joint Strike Fighter Programme', <http://www.mod.uk/DefenceInternet/DefenceNews/EquipmentAndLogistics/UkSignsUpForNextPhaseOfTheJointStrikeFighterProgramme.htm>

[17] House of Commons Defence Committee, *ITAR Waiver Defence Committee Comment* (24 November 2005)

[18] Mark Joyce, 'US defence technology exports are concerned, there is no 'Special Relationship' with the UK', *RUSI Newsbrief* (Jan 2006, Vol. 26, No. 1)

[19] Kristin Archick, *CRS Report for Congress - The United Kingdom: Issues for the United States* (Updated 16 July 2007)

US and UK can fight effectively alongside one another.

Despite this difficult history, the regulatory environment for transatlantic defence technology co-operation is beginning to improve. In June 2007 the US President and British Prime Minister signed a Defence Trade Cooperation Treaty.[20] The Treaty bypasses ITAR for certain purposes, making it easier to transmit sensitive information between the two countries, albeit at the cost of making everything classified within the UK, and therefore subject to the Official Secrets Act. The Treaty applies to defence and security actions, co-operative programmes and other mutually agreed projects in which only the US and/or the UK is the end-user. In so doing, the Treaty could significantly ease technology transfer restrictions between the two countries. However, it is important to note it is still to be approved by the Senate; its precise scope is still to be determined; and its provisions and procedures are still to be tested. It follows that in the near-term at least, later stage transatlantic defence R&D collaboration is likely to remain a complex business.

A different kind of complexity may also apply to early stage R&D mediated by the treaty. Such R&D often has multiple applications down stream, and may become mixed with other technology and develop new features on the way. Tracking back to determine whether a current technology originated (in whole or in part) from a transfer under the treaty some years before will be difficult. This could lead to disputes about whether one country has the right to veto the transfer of a technology by the other to some third party, on the grounds that the technology in question is 'contaminated' by a past transfer under the treaty. Moreover, much of the technology that ITAR currently applies to, in the US, is unclassified. The implications of making some of it classified (at least as far as the UK is concerned) and also, presumably, making the results of the joint research classified in both countries, in order to take advantage of the treaty and avoid ITAR, are unclear. Only time will tell whether these new complexities result in problems in practice.

This lengthy description of the difficulties of joint trans-Atlantic R&D collaboration in the defence domain has two purposes. First, while the case for such collaboration is strong in principle, for all the reasons set out earlier, the practical problems are also considerable. It is to be hoped that the new treaty will greatly reduce these. Second, the practical difficulties derive, for the most part, from the US International Trade in Armaments Regulations (ITAR). However, the very earliest stage of defence R&D (the so called Basic Research, in Frascati terms) is already generally exempt from ITAR, and thus has no need to use the new treaty, with all its consequent complexity, including the need to make collaborative research material classified. Seeking opportunities for defence R&D collaboration in the Basic Research area thus has much to recommend it, and we shall return to this point later.

In addition to such difficulties deriving from export controls and industrial interests, the second factor that counterbalances the benefit that alliance members obtain from collaborating on defence R&D, particularly from the US point of view, is the question of scale. While the combined GDP of the EU is similar to that of the US, there is no substantial EU vehicle for conducting defence R&D, nor body of EU defence technology. This derives from defence

[20] Defence Industries Council, *Defence Industries Council Welcomes UK-US Defence Trade Cooperation Treaty* (21 June 2007)

being regarded chiefly as a matter for member states within the founding treaties of the EU. Although steps are starting to be taken along the path to develop an EU defence identity, including the development of common defence and security technologies, only a short distance has been travelled, and the EU is a very long way from having a collective defence R&D capacity comparable to that of the US. Nor has NATO made much progress in the direction of forming an alliance-wide defence technology identity, embracing both EU nations and the US. Transatlantic defence R&D collaboration therefore necessarily means collaboration between the US and nations which individually spend less than one-tenth as much on defence R&D as does the US.[21]

That collaborative R&D nevertheless takes place (witness JSF) is due to three considerations. The first, and easiest to describe, is that by focussing collaboration on limited areas, programmes can be defined, which develop jointly-owned intellectual property on the basis of essentially similar funding: there is thus no question of the US paying most of the cost but getting only half the ownership.

The second is that in scientific research, European nations lead the world in terms of quality. Quantitative measures of scientific quality are a relatively new development, and generally make use of bibliometric data to measure output, and funding or GDP to measure input. The use of bibliometrics limits the assessments to science which is published in the open literature and hence excludes defence R&D subject to security classification. However, anecdotal evidence (including the fact that collaborative projects such as F-35 are found worthwhile by the US) suggests that similar quality extends 'beyond the wire' into the classified domains of the countries concerned.

Typical of the quality measures used are: papers published per research worker employed or per dollar spent; citations made of those papers per researcher, or per dollar spent on research, or per dollar of national GDP; and number of highly cited papers per researcher or per dollar. On the basis of such measures, small countries such as Switzerland, the Netherlands, Israel, Denmark, Sweden and Finland often have higher scores than the larger G7 nations, and among the G7 nations the UK often has higher scores than the US.[22] Given that the challenges that defence poses to technology in a changing world require innovative thinking and not just routine laboratory work, there is a case for the US to seek to harness the R&D quality to be found in smaller nations.

And, of course, there is also a case to be made for collaborative transatlantic R&D, based upon the needs of alliance interoperability. Military operations since 1990 in Iraq, Kosovo and Afghanistan have made clear the ability of the US to deploy massive military force from its own resources. Yet the consensus in the US appears to be that the US will normally operate with allies.[23] Since the EU is a long way from developing an effective collective

[21] Graham Jordan, *NATO Science and Technology: Trends, Challenges and Priorities for Reform* (London: RUSI Report, November 2005) p. 15, paragraph 22

[22] Robert M May, 'The Scientific Investment of Nations', in *Science* (Vol. 281, No. 5373), pp 49-51; DOI: 10.1126/science.281.5373.49; Robert M May, 'The Scientific Wealth of Nations', *Science* (Vol. 27, No. 5301), pp. 793-796. DOI: 10.1126/science.275.5301.793
A David, 'The Scientific Impact of Nations', *Nature* (Vol. 430, 2004)

[23] Department of Defense, *Quadrennial Defense Review Report*, 6 February 2006, p 88

military identity, this means that the US will need to operate with allies much smaller than itself. This raises a question about how such allies are to be equipped if they are to be fully interoperable with the US. Part of the answer will be to procure equipment off the shelf from the US. However, the range of allies capable of undertaking expeditionary operations alongside the US and making a useful contribution is limited. At present only the UK and France maintain forces capable of high-intensity expeditionary warfare, with Germany and Japan having the economic strength to maintain such forces, but not the political consensus to do so. (In considering France, it should be borne in mind that the differences between France and the US over the most recent Iraq war were out of line with the general run of history – French forces deployed into Iraq alongside the US in the first Iraq war of 1990 – 1991, for example.)

All of the four nations named have substantial defence industrial and technology bases, and it is difficult to see that equipping the armed forces of any of them entirely by the purchase of US equipment will ever be politically feasible for their governments. Yet, despite being G7 economies, none is large enough to equip its forces so as to be fully interoperable with the US from its national resources alone. It follows that some degree of technological and industrial collaboration with the US is essential, and in practice this means collaboration on defence R&D. The participation of the UK in the JSF project can be seen in this light, and the industrial tensions, the issue of 'appropriate sovereignty' and the protracted negotiations that have resulted are probably no more than what should be expected as necessary to resolve the resulting nexus of conflicting interests.

But, despite such motivations for international collaborative R&D, it is clearly an activity often plagued by difficulty and hindrance – witness JSF and ITAR. However, as previously indicated, earlier-stage R&D co-operation (specifically at the basic research levels) is not characterized by such complication. The results of basic research – be they defence-related or not – are invariably published, and technology transfer concerns rarely enter the equation. Indeed it is US policy that basic research should normally be freely published and disseminated, and thus exempt from constraints such as ITAR.[24] There is, therefore, added incentive to examine possibilities for international co-operation in basic research in a defence context. All the motivations that apply generally to R&D collaboration apply to basic research, and the problems, encapsulated by ITAR and the F-35, do *not* apply.

Moreover there are growing imperatives for all nations to engage in defence research at the basic research level. Demands that defence places on science and technology are changing in fundamental ways. US, UK and French forces are increasingly required to conduct counter-terrorism, counter-insurgency and force-protection operations, in which they face armed opponents who seek to make themselves indistinguishable from the civil population and yet who must be distinguished from them, and in which civilian casualties must be avoided, if the politico-military aims of the operations are to be achieved.[25] This will require new technology in terms of weapons, sensors and systems which provide the ability to distinguish people and their

[24] Presidential Directive 189 of 1985

[25] John Mackinlay, *RUSI Whitehall Paper: Defeating Complex Insurgency: Beyond Iraq and Afghanistan* (London: RUSI, 2006)

likely intentions, rather than vehicles (ships, tanks, aircraft) and their likely courses, and enable lethal force to be directed at carefully selected individual people.[26]

All of this will ask some very difficult questions of science and technology, which are unlikely to be answered without some new science. This implies either some basic research, aimed *ab initio* at a defence problem, or the drawing into the defence sphere of a science or technology that originated outside defence. As a recent report on US Department of Defense Basic Research noted, 'The breadth and depth of science and technology (S&T) essential to the DoD mission have expanded greatly in the past decade'.[27] Since less than half of all the R&D carried out in the world takes place in the US[28,29], some kind of cross border collaboration on R&D will be often be required (unless the mature technology can be bought straight off the shelf), and so the case for international R&D collaboration for defence purposes re-emerges in a different form. Added to this, the increasing speed of technological change means that governments need to be able to act in an agile and flexible manner in defence research – and, once again, this may mean drawing on technologies and specializations outside their own borders.[30] As defence draws on a wider and wider range of research efforts it will become increasingly difficult for some specialists to find potential collaborators within their own nations. Over time, therefore, pressure on government to facilitate basic research co-operation in defence with other countries will grow.

In the next section this study will expand its analysis by examining patterns of expenditure on R&D on both sides of the Atlantic. Beforehand, it is worthwhile summarizing the arguments and evidence so far. Defence R&D is something that is, for good reasons, largely government funded and so, in large measure, under government control. So too is Basic Research, whether in defence or not. Several reasons press governments to make use of the control they exercise over defence R&D, and over non-defence Basic Research that might have defence applications, to carry out some of this R&D in collaboration with friendly governments overseas. These reasons include: alliance inter-operability (taking account of the impracticability of achieving this entirely by allies buying their equipment from the US); the high quality of science and technology in countries outside the US; and the fact that, across the board, less than half of world R&D is carried out in the US. But several factors make collaboration on

[26] Graham Jordan, *Doctrine and Technology for Operations on the Cusp* in Mark Joyce (ed.), *RUSI Whitehall Report: Transformation of Military Operations on the Cusps* (London: RUSI, 2006)

[27] Committee on Department of Defense Basic Research, Division on Engineering and Physical Sciences, National Research Council of the National Academies, *Assessment of Department of Defense Basic Research* (Washington DC: The National Academies Press, 2005) p. 2

[28] Record of US Army Conference on Emerging Technology, Paris June 2007, in preparation

[29] Calculations based on GDP at Purchasing Power Parity (PPP) (or GDP per head (PPP) and population, for smaller countries), and Total Expenditure on R&D as a percentage of GDP for the 50 countries with the highest such percentages, contained in *The Economist Pocket World in Figures, 2008 Edition* (London: Profile Books), gives the US 34% of world R&D, followed by Japan (13%), China (11%), Germany (6%), France (4%), UK (4%), India (3%), S Korea (3%), Canada (2%), Italy (2%), Russia (2%), Taiwan (2%) and Brazil (2%). An alternative calculation based on GDP at Market Exchange Rates (MER), gives the US 38% of world R&D, followed by Japan (17%), Germany (8%), France (5%), UK (5%), China (3%), Canada (2%), S Korea (2%), Italy (2%), and Sweden (2%).

[30] Private communication from US Government official.

defence related technology difficult: the expectation on the part of nations investing in defence R&D (and in particular the US) that economic as well as defence advantages will flow from the investment – this naturally casts them in the role of economic competitors with their allies, as well as defence collaborators; and also fears that allies with access to US technology may not be as effective as the US in preventing it from getting into the hands of countries outside the alliance. These tensions have come to be focussed in the US ITAR system, and in general are greatest in respect of R&D in the later stages of the Frascati process (the Experimental Development associated with the F-35 project has been a particularly well publicized recent case). A new treaty seems likely to bring relief in the case of UK/US R&D collaboration, but it has some way to go before it comes into effect, and it may bring problems as well as benefits in respect of the earlier stages of defence R&D. However, the earliest R&D stage of all in the Frascati process, Basic Research, is outside both the ITAR system and the complexities of the new US/UK treaty; and Basic Research seems likely to be particularly important in finding solutions to the new and difficult problems posed by counter-terrorism, counter-insurgency and force-protection operations. This summary of the analysis so far will be drawn on in the course of the quantitative analysis of the next section.

An Analysis of Current Defence R&D on Both Sides of the Atlantic

This report will now examine the quantitative evidence about R&D in the principal countries concerned. Table 1 shows a general analysis of government funded R&D by economic sector, for the US, UK and France, expressed as percentages of total expenditure in each country.

Table 1: US, UK & Fr Federal/Central Government Funding of R&D by Area of Application (%)

	US	UK	Fr	Notes
Health	26%	7%	N/A	Dept Health & Human Sciences (US); Dept Health & NHS (UK); N/A = Not Available (Fr)
Science	4%	45%	N/A	National Science Foundation (US); Office of Science & Innovation and Research Councils (UK) - Includes Medical Research Council (4%), Biological and Biosciences Research Council (3%); N/A= Not Available (Fr)
Other	23%	16%	N/A	Includes NASA (US) - Not clear if US figures for Dept Energy include Nuclear Weapons research; N/A= Not Available (Fr)
Total Civil	53%	68%	78%	
Defence	47%	32%	22%	
Total	100%	100%	100%	

In all cases, defence accounts for a major component of government expenditure on R&D: almost half the total in the US, almost a third in the UK, over a fifth in France.

Table 2 breaks down civil and defence R&D in the US, UK and France into the three Frascati categories of Basic Research, Applied Research and Experimental Development.

Table 2: US, UK & Fr Federal/Central Government Funding of R&D by Frascati Category (%)

R&D by Frascati Category		Total	Exptal. Devt.	Applied	Basic	Other (a)
			Frascati Category			
Civil (% All Govt R&D)	US	53.0%	5.6%	21.5%	22.9%	3.0%
	UK	68.1%	1.4%	27.9%	38.8%	
	FR	77.7%	10.6%	20.6%	46.6%	
Defence (% All Govt R&D)	US	47.0%	41.5%	3.8%	1.5%	0.3%
	UK	31.9%	25.7%	6.2%	0.0%	
	FR	22.3%	19.9%	2.3%	0.0%	
Civil (% Civil R&D)	US	100.0%	10.5%	40.5%	43.3%	5.7%
	UK	100.0%	2.0%	41.0%	57.0%	
	FR	100.0%	13.6%	26.5%	59.9%	
Defence (% Defence)	US	100.0%	88.3%	8.0%	3.1%	0.6%
	UK	100.0%	80.4%	19.6%	0.0%	
	FR	100.0%	89.8%	10.2%	0.0%	
Defence (% All Govt R&D in Relevant Category)	US		88.2%	14.9%	6.0%	8.5%
	UK		94.9%	18.3%	0.0%	
	FR		65.3%	9.9%	0.0%	

Data for Table 1 and 2 sourced from: US National Science Foundation, *Science and Engineering Indicators 2006* http://www.nsf.gov/statistics/seind06/; UK Department of Trade and Industry SET, Statistics October 2005 http://www.dti.gov.uk/science/science-funding/set-stats/index.html; Ministère de la Défense/DAF/OED; Ministère de la Recherche R&D surveys; Calculations and estimations : Observatoire économique de la défense; NB: The percentages are derived from the GABORD figures given by the French Government to OECD for the Main Science and Technology Indicators (MSTI) publication (2004 data)

In all countries, a major asymmetry is apparent between civil and defence R&D: the former includes relatively little funding of Experimental Development (about fourteen per cent or less), whereas the latter consists mostly of Experimental Development (more than eighteen per cent). This reflects the fact that government funds the engineering development of defence equipment in all countries, that this is expensive, and that the expenditure is counted as R&D under the heading of Experimental Development. As a consequence, defence accounts for around ninety per cent of all the Experimental Development funded by government in the US and the UK, and about sixty-five per cent of that in France. In France, more Experimental Development is funded by government in the civil sector than in the other two countries.

When expenditure on Experimental Development is stripped out, defence accounts for much less of total government R&D, but is still significant: around ten to twenty per cent of all government Applied Research, for example. However, when the balance between Applied and Basic Research is considered, a new asymmetry emerges between civil and defence R&D. Civil research funding in both countries contains a large component of Basic Research (where research is conducted because of its potential contribution to human knowledge – sometimes called 'curiosity driven research'), as well as

Applied Research (where a practical application is in view, albeit a distant view on occasion). In all three countries' government funding of the civil sector, more is spent on Basic Research than Applied Research.

But in defence, the balance is strongly in the direction of Applied Research. In the case of the UK and France, no government expenditure on Basic Research at all is assigned to defence in the official statistics. That Applied Research is more prominent than in civil R&D is perhaps not surprising in the light of the heavy defence bias towards Experimental Development. It represents a general bias towards what might be termed the practical end of the Frascati spectrum, and reflects the interests of defence departments in funding R&D that will lead to equipment they will want to buy. Nevertheless, the apparent complete absence of Basic Research in the UK and France defence R&D portfolios is striking when comparison is made with the US, where more than a quarter of government funded defence research (Applied plus Basic Research) is Basic Research. In particular, the data may be pointing to an area of imbalance in the UK and France portfolios, or to an area where there is hidden potential for improved US/UK defence R&D collaboration, or both. This is the subject of the next section, and it needs to be considered in the light of what was said earlier in this report, about the new threats that face the western nations necessarily requiring a contribution from Basic Research to give alliance forces the capabilities to deal with them.

Defence Basic Research: a Missing Pillar or a Hidden One?

A little probing soon shows that neither the US nor the UK figures tell the whole truth about Basic Research in the defence sector (no comparable analysis has been possible for France). It has been suggested that the US Basic Research figures are inflated somewhat by programmes that are of doubtful direct relevance to defence. For example, the US figures include a cancer research programme that was placed with the DoD because of congressional direction, not defence need.[31] Conversely, the R&D reality behind the UK Defence figures may not be entirely empty of Basic Research. A Joint Grant Scheme[32] is operated between the MoD and the Research Councils (which fund most of the science basic research mentioned earlier) in order to fund university research that is relevant both to defence and to the science base. But these special cases do not change the general picture. In the US, congressionally directed medical research programmes in the DoD programme amount to no more than 0.2% of all federally funded R&D.[33] As for the Joint Grant Scheme, it appears that no figures are published for the money spent on it, but it is understood to amount to significantly less than 1% of UK defence R&D.

And the discrepancy cannot be attributed to a mere difference between the European and American definitions of Basic Research. In all UK and French government departments, including defence, the Frascati terminology is

[31] http://cdmrp.army.mil/funding/default.htm
[32] http://www.dstl.gov.uk/about_us/jgs.php
[33] Indeed, the recent assessment of US DoD Basic Research found that 'Department of Defense basic research funds have not been directed in significant amounts to support projects typical of 6.2 or 6.3 funding.' Committee on Department of Defense Basic Research, Division on Engineering and Physical Sciences, National Research Council of the National Academies, *Assessment of Department of Defense Basic Research* (Washington DC: The National Academies Press, 2005) p. 3

applied,[34] whereby 'Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.'[35] Under Frascati 'Applied research is original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.'[36] In the US, the Frascati definitions are not employed within defence, and instead national classifications for Basic and Applied Research in a defence context are used. But under this terminology, 'Basic research is systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind.'[37] And 'Applied research is systematic study to understand the means to meet a recognized and specific need.'[38] So, while the European and US departments of defence are not working from exactly the same definitions, they are, in effect, little different.

The lack of Basic Research in the UK and France defence R&D figures therefore appears significant, and raises the question, 'why?' There are three possible explanations. The first is that UK and French defence has no need for basic research. This seems unlikely because the defence requirements of the UK and France are not significantly different in kind from those of the US, which spends more than a quarter of its defence research budget (i.e., Applied and Basic Research combined) on Basic Research. In particular, the need for Basic Research to tackle the new threats facing the western nations is no different between the US and the European

[34] Office for National Statistics, *Economic Trends No 621* (Palgrave Macmillan Publishing, August 2005) p. 47

[35] *OECD Frascati Manual*, 6th edition (2002), para. 64, p. 30

[36] *Ibid.*

[37] The definition continues, 'It includes all scientific study and experimentation directed toward increasing fundamental knowledge and understanding in those fields of the physical, engineering, environmental, and life sciences related to long-term national security needs. It is farsighted high payoff research that provides the basis for technological progress. Basic research may lead to: (a) subsequent applied research and advanced technology developments in Defense-related technologies, and (b) new and improved military functional capabilities in areas such as communications, detection, tracking, surveillance, propulsion, mobility, guidance and control, navigation, energy conversion, materials and structures, and personnel support. Program elements in this category involve pre-Milestone A efforts.' 'DoD Financial Management Regulation' Volume 2B, Chapter 5, June 2006.

[38] The definition continues, 'It is a systematic expansion and application of knowledge to develop useful materials, devices, and systems or methods. It may be oriented, ultimately, toward the design, development, and improvement of prototypes and new processes to meet general mission area requirements. Applied research may translate promising basic research into solutions for broadly defined military needs, short of system development. This type of effort may vary from systematic mission-directed research beyond that in Budget Activity 1 to sophisticated breadboard hardware, study, programming and planning efforts that establish the initial feasibility and practicality of proposed solutions to technological challenges. It includes studies, investigations, and non-system specific technology efforts. The dominant characteristic is that applied research is directed toward general military needs with a view toward developing and evaluating the feasibility and practicality of proposed solutions and determining their parameters. Applied Research precedes system specific technology investigations or development. Program control of the Applied Research program element is normally exercised by general level of effort. Program elements in this category involve pre-Milestone B efforts, also known as Concept and Technology Development phase tasks, such as concept exploration efforts and paper studies of alternative concepts for meeting a mission need.' *Ibid.*

nations. The second possible explanation for the appearance of a gap is that the necessary basic research is present in the UK and French civil science base research programmes, but has not been properly identified. In the past, when it was not the practice to label items in the science base programme according to their possible eventual application, this might have been true. But in the UK at least, Strategic and Cross-cutting programmes are now an integral part of the UK Research Councils' portfolio. For example, the Engineering and Physical Sciences Research Council's (EPSRC) programme includes a programme on Crime Prevention and Detection Technologies.[39] But there is no similar programme on defence technologies.

It is also possible that there is basic research within the UK and French defence research programmes, but that it is not being reported as basic research in the official government statistics. In the course of this study the UK Ministry of Defence suggested that this is indeed the case, and that they did not differentiate between Basic and Applied Research.[40] It was further suggested that, while the distinction between Basic and Applied can be clearly established in theory, it is much more difficult to do so in practice. There is some truth in this and Frascati goes some way to acknowledging the difficulties of definition by providing for a distinction between pure and oriented basic research. Within pure basic research 'no positive efforts' will be 'made to apply the results to practical problems or to transfer the results to sectors responsible for its application', while oriented basic research is 'carried out with the expectation that it will produce a broad base of knowledge likely to form the background to the solution of recognized or expected current or future problems or possibilities.'[41] Clearly, oriented basic research could, in some circumstances, be considered applied research and vice versa.

However, in the absence of the UK MoD providing indicative figures for Basic Research (along the lines of the Frascati definitions) another explanation for the gap is simply that there is one in the UK's defence research portfolio, and that the picture painted by the Department of Innovation Universities and Science (DIUS) statistics is broadly accurate. This interpretation is supported by interviews we conducted at the London offices of the research organizations of the three US armed services.[42] They were only able to identify one example in which they collaborated with the UK MoD on a Basic Research programme.[43] (With this one exception, they carry out Basic Research collaboration in the UK only

[39] <http://www.epsrc.ac.uk/ResearchFunding/Programmes/Cross-EPSRCActivities/CrimePreventionAndDetectionTechnologies/default.htm>

[40] In contrast to the UK government-wide R&D statistics – UK Department of Trade and Industry SET, *Statistics October 2005* <http://www.dti.gov.uk/science/science-funding/set-stats/index.html>, the MoD's own data (available at <http://www.dasa.mod.uk/natstats/ukds/2005/ukds.html>) are broken down by 'Research' and 'Development' but do not record the difference between and Basic and Applied Research.

[41] *OECD Frascati Manual*, 5th edition (1993), para. 227, p. 50

[42] In the context of this study, conversations were conducted with the European Office of Aerospace Research & Development, the Office of Naval Research Global and the US Army International Technology Center – Atlantic. The findings of these interviews are included in 'The Where and How of Potential Cooperation' section.

[43] Thomas Killion, Phil Sutton, Michael Frame and Pearl Gendason, 'A New Paradigm in International Collaboration: The US-UK International Technology Alliance in Network and Information Sciences', *RUSI Defence Systems* (June 2007) p. 46. See also http://www.usukita.org/

with organizations other than the MoD – indeed, only with organizations other than the UK government.) But whether or not the UK MoD is funding basic research or not, two courses of action could be recommended. The first would be to create a programme at Research Council level on Defence Technologies, analogous to that on Crime Technologies, and to see which existing elements of the Research Council programmes can be attributed to it. The second, if that were to catch few fish in the net, would be to start such a programme from scratch.

Until such a UK programme is identified or created, it seems that US/UK defence research collaboration is missing a significant pillar, which might provide a new basis for collaboration across nearly twenty-eight per cent (see Table 2) of the US defence research programme. The fact that, as we have seen, research collaboration is easier the greater the distance from specific application, suggests that such an extension of existing US/UK research collaboration might be particularly fruitful. Even if there are significant defence resources going into basic research in the UK, and this study has not found evidence of such expenditure, a readily identifiable programme of UK defence basic research that was recognized and respected by the academic community and attracted from them some of their best ideas seems to be needed. This is the case both because of the intrinsic value of such research and because of the possibility of opening a new collaborative (and 'ITAR free') channel for collaboration with the US.

The final question that needs to be answered before leaving this topic is, however: 'why have we not noticed this gap in the UK portfolio before?' Part of the answer, from the UK end, may be that during the years in which the doctrine of the UK Research Councils' science base programme has moved from 'science for science's sake' to one in which more thematic programmes (and therefore closer to applied research) - such as Crime Technology - have become part of normality, managers of the UK defence programme have been concerned with major changes in the processes of research programme delivery, in particular the privatization of most of the UK defence research laboratories. The question may therefore have escaped attention. But perhaps just as importantly, is that it has not been normal, at the basic science/university research end of the spectrum, for government to take a role in encouraging international collaboration, save sometimes in the provision of capital-intensive facilities. It has been regarded as a matter for the research providers (usually the leaders of individual research teams) to arrange collaboration with other teams or individual workers, at home or abroad as they think fit, and as travel budgets allow. This approach may still have much to commend it. But nevertheless, strategic international research collaborations are starting to emerge in the form of partnerships between world-class research institutes. The partnership between Cambridge University and the Massachusetts Institute of Technology, was an early example which bore fruit with novel concepts of low fuel consumption and low noise transport aircraft.[44] If the gap in the UK defence basic research portfolio is closed, as we have proposed, then there must be a strong case for the two governments to encourage transatlantic research collaboration in defence basic research, using the arrangements that already

[44] <http://www.cambridge-mit.org/> and University of Cambridge News Service, 'Silent aircraft one step closer to reality', 6 November 2006 <http://www.admin.cam.ac.uk/news/dp/2006110602>

exist and that are used for the later stages of defence R&D – but without the complexities and constraints which are usually applied to classified or ITAR controlled research.[45]

It has not been possible to probe the apparent absence of Basic Research from the French defence research portfolio to the depth achieved in the UK. But it seems likely that all the arguments for generating such a programme (or separately identifying it, if it exists but is concealed within other statistical categories) will apply equally to France. In particular, the case for investing in Basic Research in order to generate better capabilities to deal with the new threats from terrorists and other irregular forces, and the attraction of generating an 'ITAR free' channel for defence research collaboration with the US, both seem to apply as much to France as to the UK.

The Where and How of Potential Co-operation

We now turn to consideration of practical measures to fill the gaps in trans-Atlantic defence research collaboration that we have identified. Not only do the UK and France appear to be missing out on potential co-operation with twenty-eight per cent (see Table 2) of the US defence research programme in a theoretical sense, but there are clear areas of mutual interest in which either country could be collaborating with the United States today. Additionally some machinery, through which such collaboration might take place, is already in existence.

As previously indicated, US, UK and French forces are increasingly required to conduct counter-terrorism, counter-insurgency and force protection-operations,[46] that demand a wide-range of new technologies.[47] These are requirements common to the three governments. In developing such capabilities, there are a number of areas of specific defence-related basic research common to two of the three countries, and some perhaps to all three. Taking the example of the UK and United States, the US Air Force publication *Air Force Long term Challenges. The 'Sky' Ahead* identifies thirty-six basic research priorities, several of which mirror those of the UK's Defence Technology Strategy (DTS). For instance, the US has named 'adaptive morphing structures'[48] as a basic research activity and the UK identifies 'morphing structures' as a 'priority technology' for Aerodynamics and Airframes in the DTS.[49] The US Air Force also cites 'Tailorable and tunable stealth materials, active camouflage'[50] as a basic research goal, and the UK cites 'multifunctional materials combining pan-spectral stealth with high temperature applicability and structural functions'[51] (though it should be noted that research in this area might quickly move beyond basic research or become classified or both). Again, the US names 'Electromagnetic and Electro-optical sensing, steering and probing techniques'[52] as a basic research objective and the UK cites 'Beam

[45] Presidential Directive 189 of 1985

[46] John Mackinlay, *op. cit.*

[47] Graham Jordan, 'Doctrine and Technology for Operations on the Cusp' in Mark Joyce (ed.) *op. cit.*

[48] SAF/AQRT report to congress October 2001, 'S&T Long Term Challenges in support of AF Vision 2020', p. 21

[49] *UK Defence Technology Strategy*, p. 97

[50] SAF/AQRT report to congress October 2001, 'S&T Long Term Challenges in support of AF Vision 2020', page 31

[51] *UK Defence Technology Strategy*, p. 54

[52] SAF/AQRT report to congress October 2001, 'S&T Long Term Challenges in support of AF Vision 2020', p. 26

steering systems for pointing and tracking'.[53]

And these are just a few examples drawn from the air environment; similar examples can readily be found in the other environments. Just as the UK Defence Technology Strategy identifies technology priorities in the marine and land environments, so does the United States' Government. The US *Naval S&T Strategic Plan: Defining the Direction for Tomorrow* names 135 S&T 'Research Areas' ranging from directed energy to bio-sensors, materials and processes. Similarly the US Army International Technology Center – Atlantic website lists sixteen areas of S&T interest ranging from non-lethal crowd control to enhanced network sensors.[54] Of course, not all of these will require basic research, but some will, and if the UK is funding such research, or is willing to do so, there is likely to be potential for collaboration.

Each of the three US services maintain technology offices in the UK that fund basic (as well as later-stage) research (and sometimes development) in the UK, continental Europe and in some instances beyond. To take the case of the US Air Force (USAF) as an example, the European Office of Aerospace Research & Development (EOARD) is a detachment of the Air Force Office of Scientific Research (AFOSR), one of ten directorates of the Air Force Research Laboratory (AFRL). EOARD's mission is to directly support AFRL research goals by: providing liaison with members of the European scientific community; facilitating contact between USAF scientists and their European counterparts; and contracting with European scientists to conduct research or support conferences and workshops.[55] The EOARD concentrates its efforts on basic and applied research and, in the course of this study, suggested that, while it found much Basic Research going on in the UK that was of potential relevance to defence as 'emerging technology', and therefore contributed USAF money to its funding, none of this funding was done jointly with the MoD or any other UK government department. In discussions conducted in the context of this study, the office indicated that it found this strange and expressed a positive willingness to seek out opportunities for collaborative funding with the UK MoD (or some other government department that funded research, if the UK judged that more appropriate).

Similarly the Office of Naval Research Global (ONR Global) acts 'as an international presence for ONR, actively seeks opportunities to promote science and technology collaboration of mutual benefit between the US and researchers around the globe.'[56] ONR Global covers both basic and applied research, as well as experimental development and, like its USAF counterpart, finds in the UK much Basic Research of potential relevance to defence that merits its funding. While some of the Basic Research they fund in the UK also receives money from UK government sources, none of this appeared to them to come from the MoD, and none was carried out as part of a collaboration with the MoD or any other UK government department. As with EOARD, ONR Global appeared quite open to examining avenues for co-operation with UK MoD in the Basic Research area.

[53] *UK Defence Technology Strategy*, p. 38

[54] <http://www.usaitca.army.mil/usa_s_t.html> accessed June 2007

[55] <http://www.london.af.mil/ Accessed June 2007>

[56] <http://www.onrglobal.navy.mil/> accessed June 2007

Finally, the mission of the US Army International Technology Center – Atlantic (USAITC-A) is 'to support the identification, acquisition, integration and delivery of foreign technology solutions to the warfighter to ensure technological superiority on the battlefield.'[57] The Center has a rather broader remit than its air and maritime counterparts, covering activities up to and including Operational System Development. While the USAITC-A has a wider scope than the EOARD or ONR Global, Basic Research in the UK is funded by the office for the same reasons as the other two US armed services support such initiatives. With one exception there is the same absence of collaboration with the MoD or any UK government department in these endeavours. The one exception is notable, because it constitutes the only example we were able to find of collaboration between the UK MoD and the US armed services, in an area that the latter regard as Basic Research (or '6.1 Research' in DoD terminology). In September 2006 UK MoD and the US Army launched the International Technology Alliance (ITA), a collaborative venture in Network and Information Sciences. The ITA

> "…brings together a world-class alliance of government, industrial and academic researchers from both nations to jointly tackle … enhancing distributed, secure and flexible networks for information delivery and decision-making is aimed at improving both nations' military capability and coalition interoperability, while providing a better understanding of the theoretical underpinnings of networking.[58]"

As such, the scheme is clearly valuable to the UK MoD, even though in its present form its focus lies solely at the academic, basic research end of the spectrum. For ITA to lead to tangible capability it will first have to transition into the area of applied research where ITAR restrictions will apply (that is at least until the new Defence Trade Cooperation Treaty comes into effect). However, the programme does represent an example of UK MoD involvement in collaborative transatlantic basic research that itself is not hampered by the later stage R&D restrictions of ITAR.

We have heard a counter-argument to the merits of basic research co-operation with the United States, along the lines that EOARD, ONR Global and USAITC-A are simply 'suck nodes' intended to capture foreign technologies for exclusively American purposes. However, whatever the merits of the argument in other areas, in the area of basic research such criticisms do not stand up to scrutiny, for the results of basic research funded by the US services are generally published in the open literature and therefore are freely available to others. In any event, any collaborative arrangements that might be set up in the future would be more likely to be agreed directly with the parent research organizations in the US, than with their London branch offices – indeed, this is how the ITA arrangement was set up. The challenge for the UK, and indeed France, is to build on embryonic successes such as ITA, and to identify or create defence basic research programmes that will enable them to seek out, jointly with the US, the new technologies that have the potential to make major contributions to solving the difficult defence and security problems of the future. Beyond this, the British and French governments might wish to draw on the American model and use the staff in their Embassies in the United

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[57] <http://www.usaitca.army.mil/usa_s_t.html> accessed June 2007

[58] Killion *et al*, *op. cit.* See also http://www.usukita.org/

States to seek out opportunities for trans-Atlantic co-operation in Basic Research, either bilaterally or collectively.

At present, somewhat strangely, two of the US armed services' offices in London, and possibly all three, are funding basic research among academic communities in the UK, for American defence purposes, while the British Ministry of Defence remains disengaged. Given the importance of new technology founded on Basic Research in providing the military capabilities required to deal with the challenges of the future, this seems hard to justify.