Case4Space Summary Report

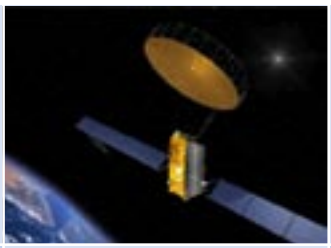
October 2006

"high value added, high-tech, high skilled science driven products and services are the key to wealth creation in the future"

Prime Minister, the Rt Hon Gordon Brown MP

Contents

The Case For Space



Space based services are indispensable and the economics of space are changing rapidly, driving expansion in markets and applications. Space will provide increased benefits to all.

1.1 Space services and applications are key to strategic and economic development across the world. And satellites play a vital role. The City uses them for synchronising financial transactions, farmers use them to improve their yields and reduce chemical use, surveyors use them to ensure pinpoint accuracy, and governments use data from them when making decisions and for secure communications. Satellites provide broadcast television, mobile communications, news and global positioning signals that enable us to reach into remote areas, stay up to date and find our way when travelling.

1.2 In years to come the world will be even more dependent on satellites and on a global space industry, forecast to be worth more than $1 trillion by 2020 from $115 billion today. The UK already leads in key areas of this market and, given adequate investment, can aspire to grow its current 7.3% share significantly, yielding high investment returns and associated social, political and security benefits. Estimates point to indirect benefits for the UK economy in transport and environment alone of nearly £15 billion per annum.

1.3 Critical to achieving these returns is the UK satellite industry and its role in providing the UK with:

- freedom and flexibility of commercial exploitation
- the means to achieve operational sovereignty (consistent with the Defence Industrial Strategy),
- means of monitoring the environment, natural resources depletion and climate change
- and through its lead in key technologies,international bargaining power.

UK Space today

1.4 The UK has established a world leading position in satellite systems, applications and services and this success has been achieved through key focussed seedcorn investment by industry and Government. Previous Government and industry decisions are sound and participation in ESA has been fruitful.

1.5 The UK space sector is vibrant and competitive, exploiting these previous R&D investments in advanced telecommunications satellite payload technology, navigation, science, Earth observation and small satellites. Government and industry's focus on these high value adding technologies has enabled UK space to produce a total direct and induced contribution of £7bn to UK GDP with one of the highest productivity metrics at four times the national average and the most highly skilled workforce in UK manufacturing with 60% holding a first degree compared with 30% for the economy as a whole.

1.6 Thirty years of development has resulted in an impressive national space "knowledge cluster". There are only two companies in the world capable of designing and building the sophisticated telecommunications technology which is at the heart of the Inmarsat 4 series of spacecraft – one of them is in the USA and the other in the UK.

Proven success

1.7 Using Treasury criteria, pound for pound, space outperforms most other hi-tech sectors by a factor of four compared with the economic average. The overall research and development expenditure of £300 million pa is equivalent to 12% of the industry's added value, and is six times more R&D intensive than the economy as a whole.

1.8 Success can also be measured in non-financial terms, satellite data has enabled the Met Office to substantially improve weather forecasting accuracy over the last 10 years by approximately 25%. Live satellite links enhance the quality and range of news, entertainment and sports programming with three times as many channels broadcast by satellite as any other platform. It has facilitated the switchover from analogue to digital as the most popular platform to receive digital television reaching 47% of UK homes with digital broadcasts. The UK has also taken a lead in building collaborations with African countries and other developing nations in disaster monitoring and humanitarian aid, particularly through smallsats.

The Case For Space

The UK is world class.

1.9 It is home to:

- the world's most profitable global mobile satellite communications provider
- the world's first public private partnership for secure military satellite communications
- Europe's most successful satellite based TV broadcaster
- the world's leading capital market for satellite and application financing
- a satellite manufacturing industry that in 2005/6 delivered the world's largest and most complex communications satellites in the world today
- world leaders in software and control for satellites and ground segment operations
- world leading scientific space research
- and the world's leading small satellite company

and it is respected worldwide for its leading position in developing applications and services using the satellite network

Tomorrow's opportunity

1.10 Space related revenues are projected to accelerate, growing by up to 15% per annum in telecom and navigation markets. The UK space industry is expected to grow and to deliver by 2015 a 60% increase in real terms on its own present day, direct contribution of £2.4 billion to GDP. An additional £2.75 billion is forecast from the spillover effects of the R&D it undertakes.

1.11 The biggest challenge to the UK's position comes from China and India where the importance of satellite technology and services is recognised as a powerful infrastructure for economic growth. As these nations develop, the trend will be for the increasingly transnational service companies to locate and procure technology from countries that have the most favourable industrial, scientific and technological climates.

1.12 Increasing investment in UK space, focusing on the UK's success and leadership in the high value adding telecoms, navigation and observation segments, will enable not only retention of a world leading position but also continued economic wealth creation, typically showing impressive returns on investment and cost effective policy implementation for the Government.

Enabling the Future

1.13 The economics of space are changing. Disruptive technologies and innovative business models are leading to a new generation of commercial products and services. Today's media satellites are 24 times as powerful as those built 10 years ago and telecomms satellites 16 times – for no increase in cost. These innovations have been driven by UK industry with Government R&D support.

1.14 In time, these commercial innovations will reduce the historical market failures that have hitherto characterised the development of the global space industry. The UK's world leadership in key satellite technologies, smallsats and applications provides the opportunity to shape and profit from this changing global market. A new national space technology programme is essential to capitalise on this opportunity and to position UK space at the heart of the national economy and the global market.

1.15 The economic importance of space is growing as is its importance as a tool in international negotiations. Space provides a means for establishing new knowledge clusters with new trading partners as the integrated global economy evolves. Collaborative programmes with India and China for trade, and with other partners in Africa for sustainable development, all offer the possibilities for establishing a new set of opportunities across the globe. The UK must also use the leverage afforded by its leadership in space to forge new links and deepen existing collaboration with Europe and the US.

Space is forging cross-border economic collaboration with rapidly growing emerging markets such as China and India.

The Case For Space

1.16 In the short term, Government intervention remains essential to share the technology risk which industry and the capital markets find it difficult to absorb in the current conditions of market failure. In the longer term the Government's role could change, from predominantly a partner in the risk sharing to a user of the growing portfolio of innovative space based solutions, which could revolutionise the delivery of public policy.

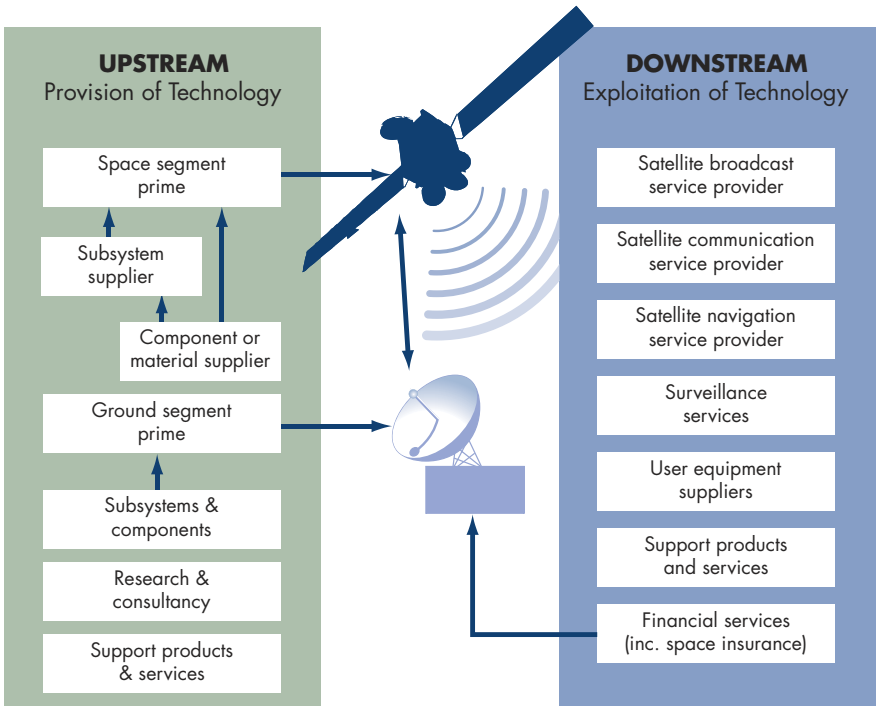
1.17 To ensure future prosperity and security, there must be renewed public investment in space technology and better co-ordination of its use across Government.

1.18 This will underpin the Government's objectives for:

- future prosperity,
- sustainable development,
- national security in the face of new and complex threats,
- understanding and monitoring of climate change so that these achievements are not prejudiced by runaway changes to our planet,
- inspiring a new generation into science.

1.19 It will also provide a means for enhancing the efficiency of the Government's own working, through access to new sources of information and communications, with control over their operation where needed.

1.20 In the economic analysis written by Oxford Economic Forecasting for the Case for Space, it was noted that there are significant technological and financial barriers for new entrants into the space industry. The UK has already made the investment to overcome these barriers so that future investments should show stronger returns.



Source: Size and Health of the UK Space Industry 2006

1.21 Studies commissioned for Case for Space covered: Economics; Industrial Policy; Satellite Communications; Environment; Green; Science; Skills and Education; Benchmarking; Security and Transport.

Economic Benefits ~ Today

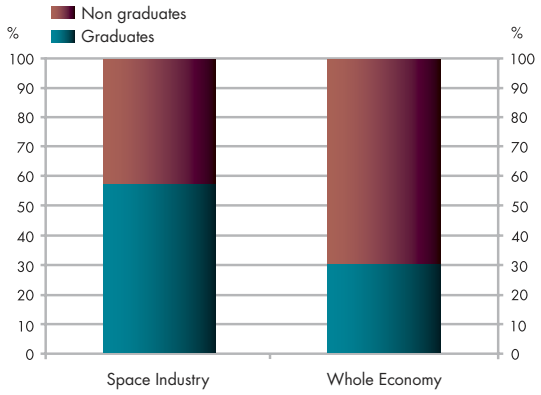
The UK space industry is one of the UK's leading growth sectors...

2.1 The UK space industry is a UK success story, growing in real terms by over 10% a year since 1999/00 – four times faster than the economy as a whole. And it has potential to accelerate this growth over the next decade as new technologies and applications are developed that rely on space derived data and services, including location based services for mobile phones and improved satellite data for weather forecasting.

...and a substantial industry in its own right...

2.2

- On a turnover of £5.2 billion, the UK space industry directly contributed around £2.4 billion to UK GDP in 2004/05. This results in an induced total of nearly £7 billion GDP
- Direct employment in the UK space industry was 17,560 in 2004/05.
- The space industry is one of the UK's most highly productive sectors, with GDP per worker around £135,000 in 2004/05 – nearly four times higher than the economy average.
- In part, the space industry's high productivity reflects the very high levels of capital investment undertaken by firms in the sector. The industry's labour force is also highly skilled, with nearly 60% of workers being qualified to at least graduate level - compared to 30% for the economy as a whole.
- The UK's modest investment in the European advanced telecommunications technology programme (ARTES) has generated returns on investment of more than 7:1. Investment in ARTES led directly to the revolutionary digital processors that enable broadband via satellite through the Inmarsat BGAN service.
- Returns on commercialisation of research of 100:1 have been demonstrated.
- The investment in the UK led Disaster Monitoring Constellation has generated returns of 9:1 to date.



Source: Size & Health of the UK Space Industry 2006

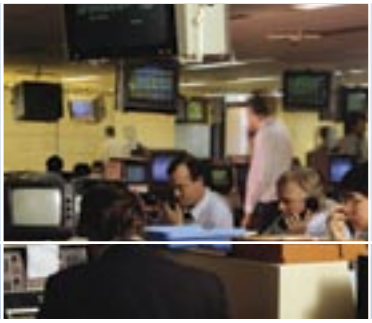
Qualifications in the space industry

... and supporting almost 70,000 jobs in the UK both directly and through its spending

2.3

- As well as being a substantial generator of activity in its own right, the space industry also stimulates GDP and employment throughout the rest of the economy. For example, almost 38,000 UK jobs are supported by the purchase of goods and services through the space industry's supply chain. And the spending of workers directly and indirectly employed by the space industry helps to support a further 14,000 UK jobs.
- In total, the space industry helps to support almost 70,000 jobs and generates about £5.2 billion in GDP through direct and economic multiplier impacts.

Economic Benefits ~ Today



"high value added, high-tech, high skilled science driven products and services are the key to wealth creation in the future"

Prime Minister, the Rt Hon Gordon Brown MP

The space industry also helps to improve the performance of the wider economy...

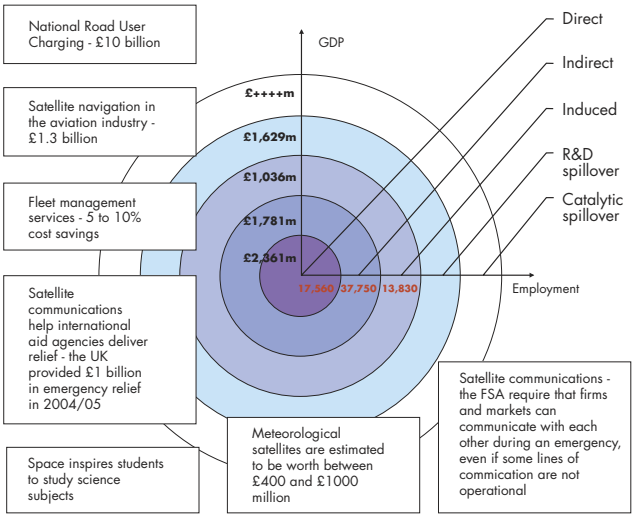
2.4

- And the contribution of the space industry to the UK economy goes much wider. In particular, there are catalytic or spillover impacts that facilitate improved supply-side performance of the UK economy, creating capabilities and enhancing productivity across the wider economy.

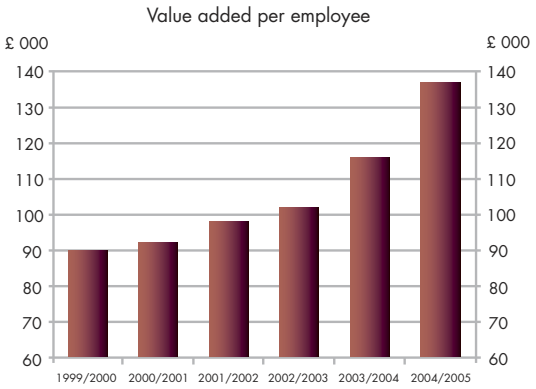
... supported by its substantial investment in R&D.

2.5

- Overall research and development (R&D) expenditure in the space industry in the UK was £300 million in 2004/05. This level of investment is equivalent in monetary terms to 12% of the industry's value added (ie its GDP contribution). This means that the UK space industry is about six times more R&D intensive than the economy as a whole, ranking alongside the most R&D intensive sectors in the UK today.
- The technological advances that come about as a result of R&D investment in the space industry can be transferred to firms in other sectors in the form of 'spillover'. Research by Oxford Economic Forecasting (OEF) suggests that such spillover effects are very large, with R&D investment by the aerospace sector generating a social return of around 70% - ie every £100 million invested in R&D as well as the direct benefit leads to an additional spillover increase in GDP of £70 million in the long run.
- OEF estimates that the space industry helps to generate an additional £1.6 billion a year of GDP through the spillover effects of its R&D, on top of its £5.2 billion of direct and multiplier impacts. So, the space industry overall currently contributes at least £7 billion a year to UK GDP.
- On top of this, the application of space derived services and data further contributes to the UK economy by facilitating a wide range of services to business and consumers, and by enabling the UK's economic infrastructure to function more efficiently.



The contribution of the UK space industry and examples of catalytic effects



Source: Size & Health of the UK Space Industry 2006

Labour productivity in the space industry

Economic Benefits ~ The 10 Year Vision

Space based services are already indispensable...

3.1

- In 10 years the world will be even more dependent on the satellite infrastructure, for communications and broadcasting, accurate positioning and navigation, and observation and monitoring.

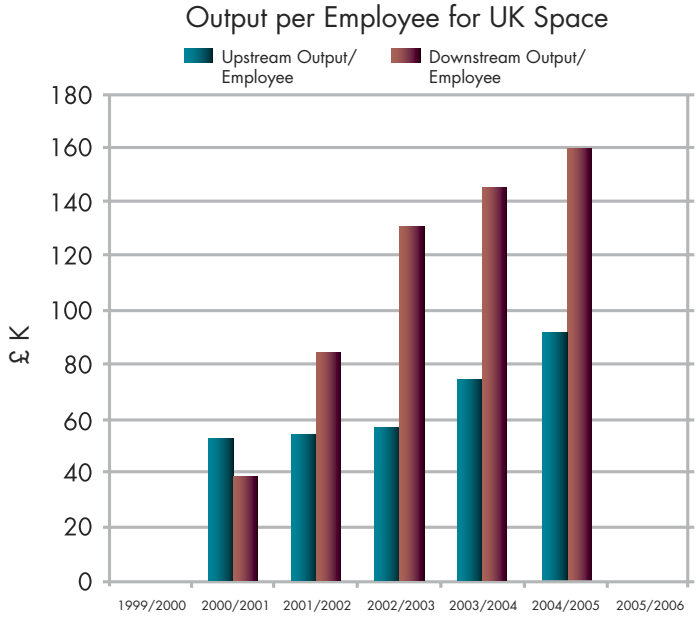
... and the economics of space will change rapidly...

3.2

- New technologies and business approaches, in which the UK has shown itself to be a global leader, will result in dramatic and ongoing cost reductions and performance gains in these applications, creating multiple opportunities for expanding business and competitive positioning. Recognising this, the UK has set out to focus on the provision of the in-orbit satellite infrastructure itself, achieving this through selective partnering with other countries.
- Key to this is UK Government and industry investment in future key technologies for the satellites themselves, including advanced telecoms systems, navigation, radar and optical sensors, small satellites, control systems, and in satellite operations management systems and applications development. The UK can lead in revolutionising the economics of space.

> Space is increasing the pace of innovation and its technological reach

- UK productivity in space, already one of the highest in the economy, is forecast to increase by a further 50% by 2015.



Source: Size and Health of the UK Space Industry 2006

Economic Benefits ~ The 10 Year Vision

...driving expansion in markets...

3.3

- In 15 years the global space industry is forecast to be worth $1 trillion. Space related revenues are projected to accelerate, growing by up to 15% per annum in telecom and navigation markets. The UK space industry itself is expected to grow and to deliver a 60% increase in real terms on its current, direct contribution to GDP by 2015.
  An additional £2.75 billion contribution is forecast from the spillover effects of the R&D it undertakes.
- From its present areas of leadership in technology and applications and current 7.3% market share (fifth in the world) the UK can aspire to grow its share significantly, with high investment returns for industry and Government and associated social, political and security benefits.
- Government can take action on regulation to stimulate free and competitive markets and growth in services that use the satellite and space infrastructure.

...and applications...

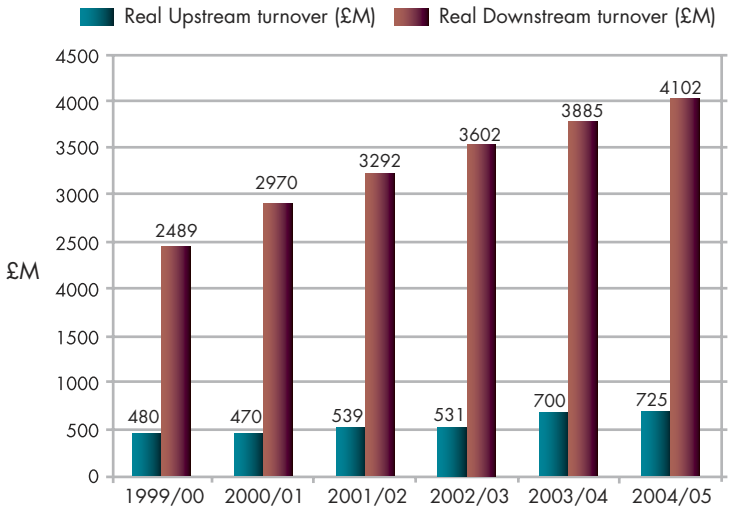
3.4

- Making space an indispensable highway for gathering and communicating information in the 21st century global economy and across political systems.

...providing increased benefits

3.5

- Estimates point to spillover benefits for the UK economy in transport and environment alone of nearly £16 billion pa.



Source: Size and Health of the UK Space Industry 2006

Economic Benefits ~ The 10 Year Vision

Satellites and Telecommunication Services

3.6 Risk reduction R&D investments from Government together with matching investments from industry have created a world class industrial position for the UK.

3.7 Satellite telecommunications technology underpins the growing contribution of UK space to national economic growth generating real economic return benefiting the whole sector and many other parts of the economy, from satellite media and broadcasting to the telecoms sector. The satcom sector currently represents around 80% of the UK space commercial activity.

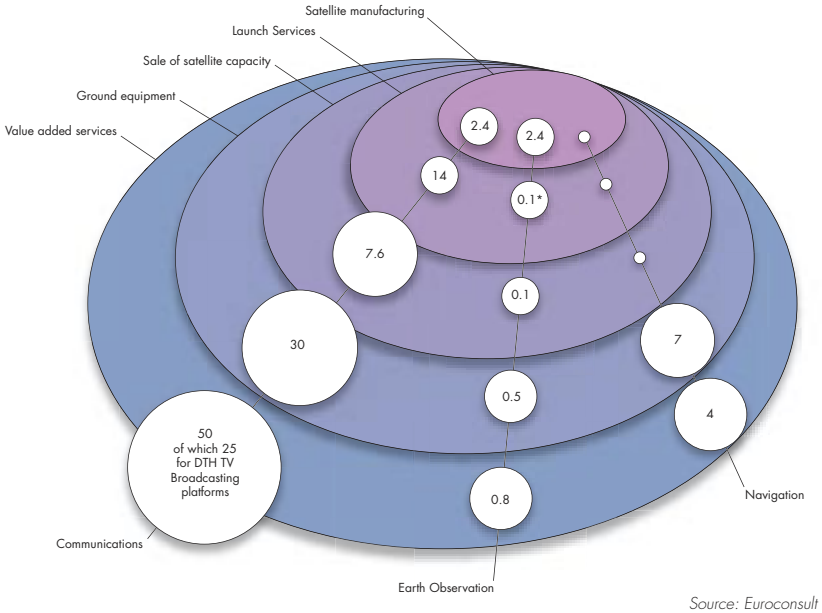
3.8 Satellite telecommunications in the period to 2015 will continue to:

- grow at six times the rate of GDP
- drive the space industry's exceptionally high value added rating ahead of other hi-tech manufacturing sectors such as aerospace or software, a crucial index in the eyes of the Government
- generate billions of pounds in related downstream businesses, for example adding £1 billion to the media sector alone. Downstream revenue from commercial satellite operators has grown by 44% in the last three years and is predicted to continue to grow into the future.

3.9 A modest step up in the investment from public and private funds can establish the UK as world leader in the field. The recent launch of the Hylas programme by Avanti of London provides a successful model for this partnership approach.

Satellites and Positional Services

3.10 Positional services and applications, driven by satellite navigation and the precision timing delivered by those systems will grow dramatically in the next 5-10 years, as increased accuracy and more assured service is provided by the Galileo programme. Galileo, combined with the less functional GPS and 3G/4G mobile phone technology will bring positional services to all aspects of our lives. Satellite navigation will be part of every mobile phone, every car/plane/ship, tracking every high value asset. The applications market will become central through cost effective implementation of road user charging, prisoner tagging, 999 location, etc.



Source: Euroconsult

Worldwide commercial satellite value chains 2003 (US$ billion)

Economic Benefits ~ The 10 Year Vision

3.11 The value of the indirect benefit to the economy of transport applications is estimated to reach £15 billion pa by 2015.

3.12 The UK is well positioned to benefit from this rapidly expanding market as UK industry, supported by Government investment in Galileo, leads the platform demonstration, navigation payload and ground control aspects of the infrastructure programme. There will also be opportunities for the UK to provide early service solutions.

3.13 The UK can lead Europe in this service and application sector through full engagement with downstream industry to allow first to market opportunities.

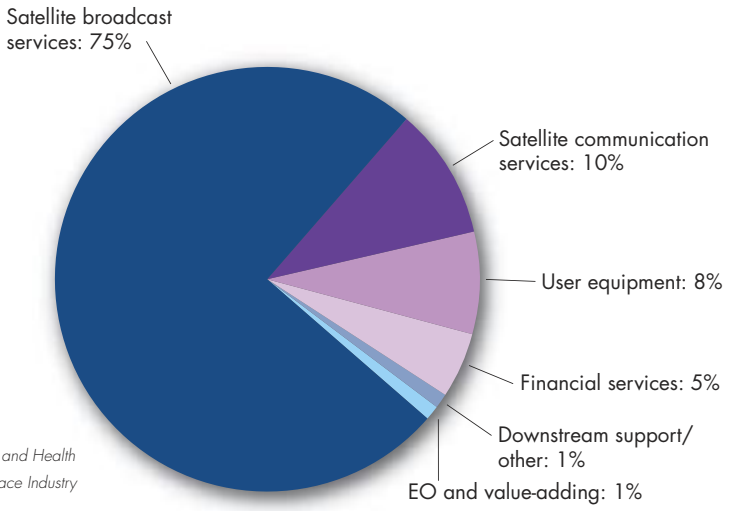
Satellites and Surveillance and Observational Services

3.14 Weather forecasting is already dependent on satellite technology. In the longer term, new services and applications based on near real time pictures from space will develop as this media becomes more cost effective through new developments in imaging technology coupled with small satellite technology (led from the UK). Today this is used by farmers, security forces, disaster relief workers and others. But as UK investment in R&D bears fruit it has the potential to support public policy objectives and also to improve the efficiency of public services by providing more capable tools and better information and a host of new applications will emerge covering detection of illegal fishing, border monitoring, pollution policing etc

3.15 The value to the UK economy of the contribution of satellite data to better weather forecasting is on its own worth up to £1 billion pa. The ability to predict natural hazards as a result of satellite observations could save up to $1.5 billion globally.

3.16 An expanded space-based security system will be in place by 2015, primarily though not exclusively part of an international network, and this will be crucial in counter-terrorism and combating organised crime and people trafficking. Space based systems will not only be increasingly central to these functions, but will also reduce the economic cost of protective counter-measures. Again, the UK is well positioned to benefit from providing the satellites and support services, but this could be jeopardised if the UK fails to engage fully in ESA's GMES (Global Monitoring for Environment and Security) programme and the associated EC user led support.

3.17 This market will grow rapidly and the UK is already one of the market leaders. A full and central role in the next round of European programmes will allow the UK to exploit this major opportunity fully.



Source: Size and Health of the UK Space Industry 2006

Downstream turnover 2004/2005

Policy Benefits ~ Transport

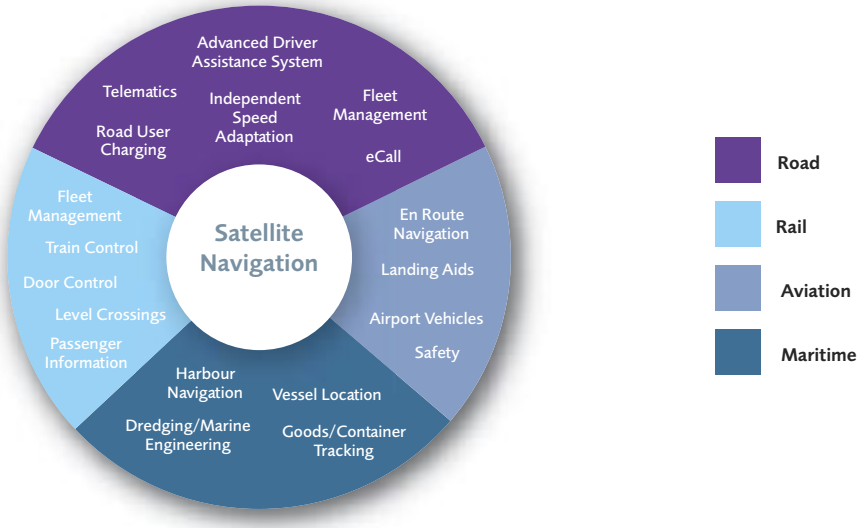
"The transport challenge of the next 50 years will be to use technology to deliver infrastructure that will stimulate economic growth, support social cohesion and be environmentally sustainable."

Sir David King, Chief Scientific Adviser to HM Government

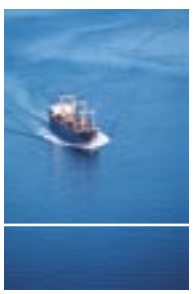
4.1 Intelligent transport infrastructures are key to the sustainability of the UK's economic and environmental development. The Government is committed to a fairer taxation policy for road usage and at the same time manage congestion, by introducing a road user charge based on time of day, class of road etc. The private sector is already piloting motor insurance schemes to base premiums on location, time of day and how vehicles are driven. The Home Office is using prisoner tagging schemes to track offenders. European legislation is being introduced to ensure the movement of live animals is tracked to control the spread of contagious diseases. The movement of dangerous goods, such as nuclear fuels, will have to be tracked to comply with new legislation.

4.2 All these policy initiatives require position and time data - which can be provided with least impact on the environment via satellites. These initiatives will serve to increase both government and public dependence on the uninterrupted provision of signals. The success of these policies is linked strongly to both the system performance and the guaranteed availability of signals, and implicitly requires Galileo and not just GPS. Galileo provides increased signal availability, significantly superior signal design, a service guarantee and integrity of service. The use of GPS plus Galileo delivers the best performance of all, by combining signals from the two constellations (nearly 60 satellites), dramatically increasing signal availability.

4.3 The use of satellite navigation in road vehicles is growing and systems are anticipated to be installed in the majority of vehicles in 10 years. Satellite navigation brings unique benefits to road users in terms of time saved, reduction in accidents, theft and emissions.



Transport - space applications



Policy Benefits ~ Transport

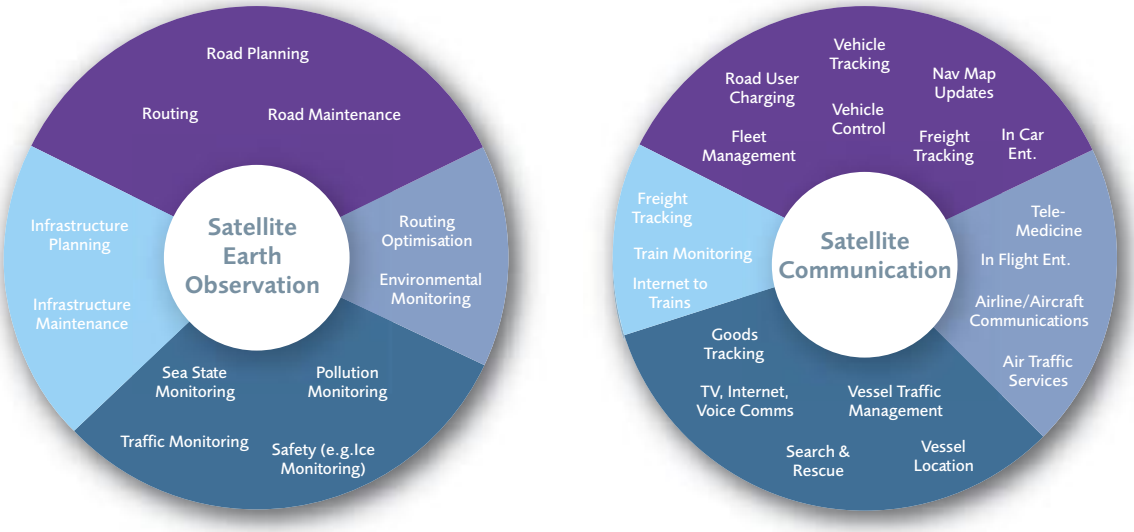
4.4 This level of satellite navigation penetration in road vehicles will help save road users considerable time (other studies estimate this at 15%). This should lead to savings of over £10 billion for UK drivers (both commercial and leisure) and further savings to society from reduced emissions of £0.5 billion.

4.5 Satellite navigation systems such as eCall that enable the emergency services accurately and speedily to locate accidents on the roads will help save lives and reduce serious injuries. Speed alert/advanced driver assistance systems which give collision and speed warnings will also reduce the number of accidents. The total benefit to the UK from reduced accidents is estimated at £1.7 billion per year in the future.

4.6 Satellite navigation systems that enable stolen vehicles to be tracked and then disabled are estimated to be worth £1.5 billion per year to the UK in the future. Statements from the police confirmed the success of small scale trials of such systems.

4.7 Total UK benefits from the use of positioning systems in the aviation industry, enabling more efficient use of airspace, are estimated at around £1.4 bn per year. This will increase as Galileo comes into operation with consequent increase in accuracy. The UK is playing a leading role in establishing early signal and service demonstrations.

4.8 The improvements in transport capacity and flow resulting from GNSS (Global Navigation Satellite System) enabled traffic management will permit continued growth of the economy without the pressure for major changes or additions to transport infrastructure, restrictions on social mobility, increasing congestion and the environmental damage experienced hitherto. This will break the link between economic growth and the growth of transport.



Transport - space applications

Policy Benefits ~ Environment

5.1 Satellites are shaping our understanding of the natural world and our impact on it. Satellite based observations of Earth are giving policy makers continuous, global and accurate data, and are underpinning the evidence base behind our environmental policies.

5.2 UK space is working in partnership with Government to offer practical, low cost contributions to the understanding and mitigation of environmental and sustainability questions.

5.3 Underlying effective action on the environment must be continuous improvements to our understanding of the Earth system, achieved through effective observation of the natural systems usually on a global scale.

5.4 One of the largest environmental problems currently facing society is climate change. Action in response to climate change is a top priority for the UK. The issues are complex, affecting people in the UK through rising sea levels and extreme weather but also having more dramatic effects on vulnerable regions such as Africa.

5.5 The UK space community has made leading contributions to climate change science, mainly through the ESA Explorer Programme, and should maintain that leading position by full participation in satellite observing systems within internationally coordinated programmes such as GMES as part of the GEOSS initiative and the Eumetsat series of satellite. The European Space Agency-EU Global Monitoring for the Environment and Security (GMES) initiative is the major European contribution to the Global Earth Observation System of Systems (GEOSS). A decision to fund at full GDP levels the next phase of GMES is imperative.

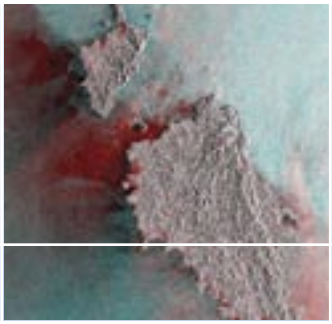
5.6 Constellations of small affordable satellites, can also play a major part in addressing environmental key objectives. Such constellations provide the opportunity to involve developing countries as active participants through their own satellite programmes, as in DMC (the Disaster Monitoring Constellation), in global efforts to address climate change.

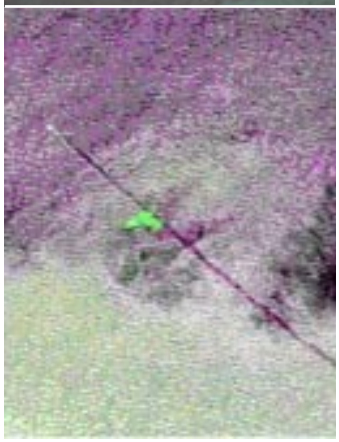
5.7 There is a growing volume of analysis which shows there are considerable socio-economic benefits of space derived data and information. The Oxford Economic Forecasting study points to gains to the UK of between £400m and £1000m per annum resulting from satellite meteorology.

5.8 Key applications derived from the use of satellites in support of environmental issues and sustainable development strategy are:

- **Climate Change.** Satellites are the best way to highlight gradual environmental change on a global scale. UK space has developed world-leading expertise in analysing global atmospheric behaviour and greenhouse gas emissions.
- **Flood and Land Cover Monitoring.** Long term Earth observation from space helps to protect and manage natural land cover and coastlands threatened by climate change and sea level rise.
- **Disaster Management.** Space observation plays a critical role in tracking, monitoring and assessing natural hazards including tsunamis, earthquakes, volcanoes, and severe weather phenomena. Mitigating the impact of these disasters requires a better integration of observations from various Earth observing systems, improved predictive modelling, and the dissemination of timely and accurate information. Satellites have a unique capability to cover all remote sites and disseminate information immediately to users at local, regional and global levels. Disaster prevention and mitigation represent an area where space is a fundamental tool for all countries, especially developing ones.
- **Sustainable Development – Africa:** Space supports the development of more sustainable African communities, providing a direct communications infrastructure, access to educational opportunities and enhanced environmental monitoring to deliver basic human rights of freedom from hunger and disease. This is evidenced by the participation of African nations in the UK led Disaster Monitoring Constellation, which is enabling them to assess the early effects of climate change, to which they are already highly vulnerable.
- **Sustainable Forestry and Marine Production:** Satellites play a vital part in supporting sustainable production through the monitoring of forest over-harvesting and fire damage, as well as the assessment of the release of greenhouse gases. Satellites are

Policy Benefits ~ Environment

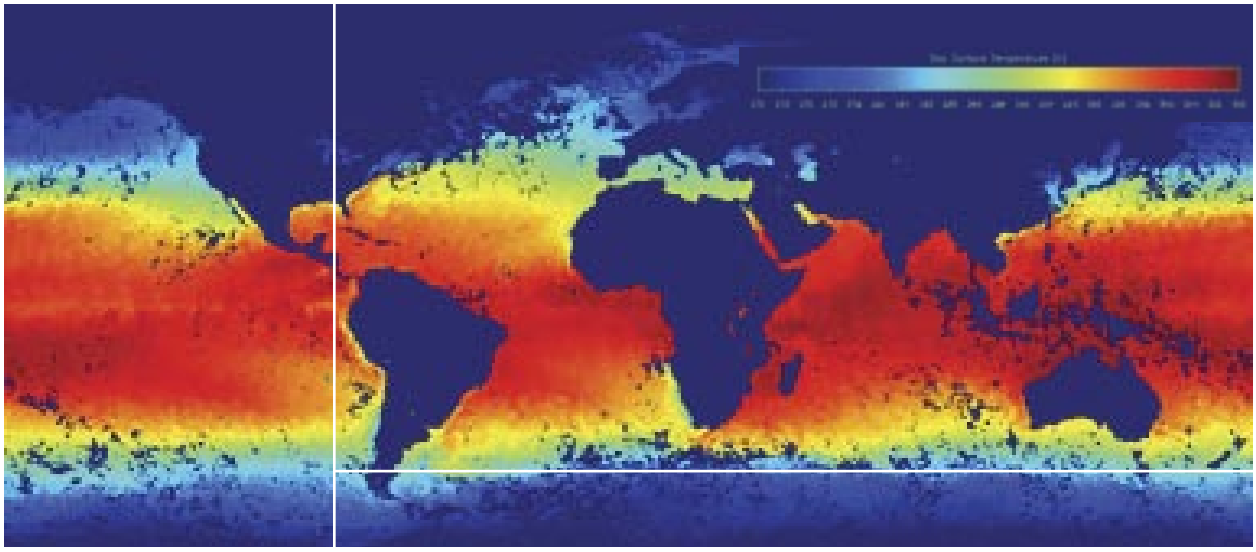




also increasingly important for marine production through the protection of fish stocks from illegal fishing, and management on the basis of fish stock assessment.

- **Sustainable Urban Management.** Space derived information provides a holistic approach to decision-making across a wide range of urban policy areas. It brings together information which is typically heterogeneous and disparate; to support an integrated system of data collection, modelling and applications which is the key to the sustainable development of cities.
- **Low Emission Transport.** Satellites can play a vital role in improving transport efficiency providing an unobtrusive and cost effective global service. Space based systems can reduce road congestion and increase efficiency of road haulage, help to manage air traffic and reduce fuel wastage and increase capacity and improve safety whilst cutting greenhouse gas emissions. Space also informs shipping for routing to avoid adverse conditions thus cutting journey times and reducing emissions. Developments in advanced weather monitoring may also enable aircraft to benefit from high altitude winds further increasing efficiency.
- **Green Telecommunications.** A satellite-only based TV broadcasting system for the UK would provide a real digital dividend in terms of increased spectral resources and reduced carbon footprint. Of the 1100 UHF transmitters which provide the current analogue terrestrial TV service in the UK, the 50 most powerful require 54MW of electricity – resulting in 250,000 tons of CO_2 per annum. Satellites use electricity from sunlight to power transmissions during their 15 year operational life. The frequency spectrum due to be released as part of the switch from analogue to digital broadcasting will be able to carry approximately 14 HDTV channels – the latest European telecommunications satellite launched in August 2006 can carry 150 HDTV channels. Industry is also working to introduce self-powered wind-up satellite receivers for the developing world.
- **Illegal oil dumping.** Policing of environmental legislation will be key to making progress. Only satellites offer a cost effective global mapping solution.

Space is monitoring our management of pressures on natural resources and global climate and is helping to provide 'green' alternatives to terrestrial infrastructures



Policy Benefits ~ Defence and Security

6.1 Space-based equipment is essential to national security. Satellite communications are vital to the full spectrum of military missions from controlling nuclear retaliatory forces, through expeditionary warfare and peacekeeping missions to humanitarian and civilian aid work. Satellite observation is crucial to reconnaissance, surveillance and monitoring with data underpinning military, diplomatic and homeland security actions.

6.2 The global nature of terrorism and serious international crime requires security agencies to coordinate their activities and share information to an extent unthinkable a decade ago. This need for greater interoperability has placed a huge burden on the existing communication and data transfer infrastructure. A physical presence of UK personnel may often be necessary in remote locations where only secure satellite communications systems can be used to communicate back to home base.

6.3 Through its family of Skynet satellites, the UK has been a pioneer in the use of military comsats supporting national and allied military missions. Milcomsats and other space-based assets will be at the heart of the network enabled capability (NEC) which is the basis of MoD strategic thinking. This approach requires rapid access to intelligence by the appropriate stakeholders to develop a Common Operational Picture and improve overall situational awareness. The use of satellites is frequently the only method to provide timely information to decision makers.

6.4 But the importance of space-based equipment extends beyond the MoD. The need for information from space based communications, navigation and surveillance assets will derive from departments including the Cabinet Office, DEFRA, FCO DfID, DfT, the Home Office and a broad range of agencies such as Maritime Coastguard Agency and the Environment Agency.

6.5 The use of satellites in a maritime environment is especially important for the UK with the International Maritime Organisation based in London. An efficient and safe maritime industry relies heavily on a ubiquitous satellite infrastructure such as that operated by Inmarsat. With the increase in world trade, larger volumes of goods are being shipped by sea than ever before. High value goods provide a target for international piracy, which often operates hand in hand with international terrorism and serious organised crime including people smuggling.

6.6 Space based capabilities also play an underpinning role in supporting the Government's international policy and treaty commitments. Previous UK investment in space programmes has enabled the Government to maintain a presence in and influence activities of European, US and international organisations related to multinational security programmes as well as contributing to international policies and treaties via bodies such as the United Nations, NATO and the European Defence Agency.

6.7 The FCO's telecommunications network (FTN) uses satcoms to support overseas communications. The FTN currently provides secure voice and data communications to over 230 sites worldwide including embassies, high commissions and organisations such as the EU and NATO.

Policy Benefits ~ Defence and Security

6.8 An expanded space-based security system, primarily though not exclusively part of an international network, will be crucial in counter-terrorism, combating organised crime and people trafficking. Space based systems are not only central to these functions, but they can also reduce the economic cost of counter-measures.

Space is helping to address the ongoing threats of international terrorism and global conflict

6.9 The asymmetric nature of contemporary security threats means all countries are potential targets and sources of terrorism. Surveillance must therefore be available on a global basis. Earth observation also has an important role to play in understanding environmental pressures on society and planning for the consequences. At present the UK makes decisions based on foreign owned space surveillance assets.

6.10 The ability of the space industry to support the projection of UK international policy is largely predicated on the UK retaining an independent space capability with on-shore research and industrial knowledge and skills. UK expertise in optical and radar observation, combined with low cost smallsats, are increasingly providing utility in surveillance applications.

6.11 An independent UK space capability ensures:

- National control of space assets enabling greater flexibility in both policy and actions.
- The freedom to exploit intellectual property and develop spin off from the space sector without restrictions being imposed by international partners.
- Benefits for UK industry and research, enabling dual technology exploitation and reducing generally the overheads associated with developing platforms and payloads.

This is consistent with the concept of Operational Sovereignty announced in the recent Defence Industrial Strategy.

Policy Benefits ~ Science

7.1 Britain is a world leader in space science and space science is a crown jewel in Britain's science base. Space science and astronomy have been drivers for civil space activities in the UK and Europe since the 1960s. The longstanding, close and productive interaction between the science base and the space sector has led to the development of revolutionary and sophisticated satellite payload technologies. The development of Earth observation and sensing technology has moved in parallel with the need to understand the Earth as a system, driving the science of Earth observation and encouraging the exploration and development of new technologies. These include Natural Environment Research Council (NERC) sponsored Earth Observation Centres of Excellence. Space also brings major benefits from knowledge transfer and technology spin-out. Space science is also an important source of inspiration for scientific education.

7.2 The main scientific customers for UK space are the Particle Physics and Astronomy Research Council (PPARC) and NERC. PPARC's space science goals address some of the most fundamental questions about the origins of the universe, its physical and chemical characteristics and processes and whether life exists elsewhere. NERC uses space-based equipment to deliver world-class environmental science to aid our understanding of the Earth.

7.3 Space offers a unique environment to make observations about the solar system and the universe and to provide a global view of the Earth and increase understanding of the Earth as a system.

Role of Research Councils

7.4 Both research councils engage with space through the scientific exploitation of existing space facilities, the development of new facilities through the provision of new scientific instruments, and the preparation for future facilities through technology development. To achieve this, they contribute funds to collaborative European Space Agency (ESA) programmes that support both the development of specific space missions and the advancement of technology.

The UK satellite industry strongly supports the Aurora programme and is already involved in knowledge transfer initiatives.

		Aurora Technology Cluster						
		Propulsion Systems	Energy & Gas Generation & Storage, Cryogenics	Robust Autonomous Systems & Robotics	Extreme intelligent Sensors and Analytical Instruments	Robust Avionics, Navigation & EDLS	Operational Infrastructure	Planetary Protection
Major Potential Markets	Space	●	●	●	●	●	●	
	Defence & Security	●	●	●	●	●	●	●
	Aerospace			●	●	●	●	
	Transport		●	●	●	●		
	Power / Energy		●					
	Science		●		●			●
	Analytical Instruments		●		●			
	Healthcare		●	●	●			●
	Telecomms		●	●			●	
	IT & Software			●			●	

Policy Benefits ~ Science

7.5 The most important current ESA science delivery programmes for PPARC and NERC are the core Science Programme, the Aurora Exploration Programme, and the Earth Observation Envelope Programme. By exploiting their unique characteristics, UK space scientists also compete successfully to win PPARC and NERC grants for national programmes.

Successes and Maturity of Engagement by the Research Councils

7.6 UK scientists have played a leading role in ESA sponsored missions and have acquired a world-class position in the field of space science and Earth observation. UK centres have led key elements of the Mars Express, Venus Express, Huygens-Cassini and BepiColumbo programmes. Other notable achievements include the use of space to monitor arctic ice levels using the ERS and Envisat missions.

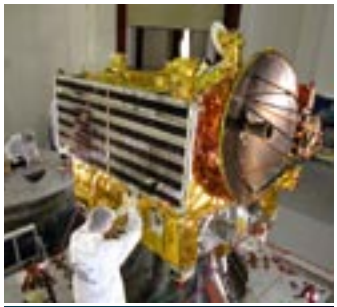
Industrial engagement with science for space

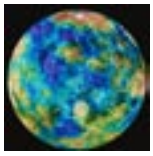
7.7 ESA programmes are the primary focus for PPARC and NERC space funding. This provides a vital route for British industry in the development, construction and testing of spacecraft. ESA participation guarantees an industrial return to the UK and differs considerably from many other international subscriptions where UK industrial return may be extremely low.

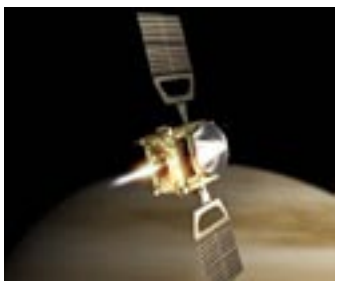
7.8 Equally, the NERC and PPARC national programmes also provide opportunities for UK industry on scientific space projects. Smallsats can provide opportunities for flexible, rapid deployment of novel payloads, enabling UK scientists to stay ahead. Other opportunities include joint technology development with university research groups and funded programmes to encourage knowledge transfer. The latter involves both the space and non-space sectors.

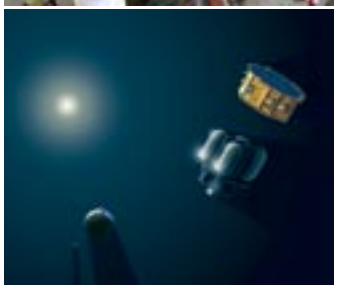
7.9 Examples of knowledge transfer from space to other sectors include:

- Terahertz Imaging developed for Earth atmospheric monitoring has been used to improve medical scanning and airport security systems.
- The Beagle-2 Miniature Lab is being developed for terrestrial healthcare, environmental and security markets.









Policy Benefits ~ Education and Skills

8.1 Space is used at all key stages in schools and across many subjects. This encourages students to take an interest in science and has an equal effect for boys and girls regardless of ethnic origin. Education choices for older students are also influenced by space. Further to this, the space industry encourages the study of science degrees. Space was the second most popular factor motivating choice of physics as a degree.

8.2 STEM subjects (Science, Technology, Engineering and Mathematics) are a major Government priority. A key 2006 Budget paper stated the need to increase passes at Key Stage 3, GCSE and A-levels in science and maths and to step up recruitment, retraining and retention of specialist teachers. There is much anecdotal and some quantifiable evidence that using space in the school curriculum will help to achieve these targets.

8.3 The space industry employs proportionally twice as many graduates compared with the economy as a whole. Graduates entering the space industry and space research acquire valuable skills and training in important subjects such as mathematics, control, high reliability engineering, safety critical systems and project management, which are then transferred with them to other employment in manufacturing and finance for example. These graduates working in other industries generate additional revenue for the Exchequer, helping the UK to be a more productive and competitive economy.

8.4 Experience in the space industry and research adds value to CVs. Involvement in space also conveys credibility in other non-space sectors of the economy, particularly for UK companies exporting to the US and other space nations.

Policy Benefits ~ International Development

Photograph: Freeplay Foundation

9.1 In 2000, through its White Paper *Eliminating World Poverty: Making Globalisation Work for the Poor*, DFID led the international debate on the growing digital divide that threatens to further deepen the exclusion of parts of sub-Saharan Africa. The White Paper focussed on the advantages of harnessing ICT, including the internet and satellite communications, to share skills and knowledge with developing countries, and to use it to improve education and governance and to create new opportunities.

9.2 Future satellite-based broadband services and mobile broadband from space can transform the communications infrastructure and leapfrog Africa into the networked world, permitting Africans to work with information and provide services in world markets without the need for emigration and skills drain. In this vast continent with a lack of ground-based infrastructure, affordable and low-energy broadband technology using satellites offers unrivalled potential for providing improved public infrastructure and services to people in rural areas.

9.3 The 2005 G-8 Summit at Gleneagles made a commitment to help developing countries obtain full benefit from the *Global Climate Observation System (GCOS)*[1] Global Earth Observation System of Systems (GEOSS). The potentially disastrous consequences of climate change on water and agriculture in Africa have become a strong concern for DFID[2]. This will lead to increased interest in environmental, vegetation, weather and climate monitoring from space.

Policy Benefits ~ International Development

"Britain's world leadership in space represents a tremendous, perhaps unique educational opportunity - to re-engage young people in science, engineering and technology, and to help build the right skills base for Britain."

Professor Sir Gareth Roberts, author Roberts Review, 'SET for Success' for HM Treasury.

9.4 One current example for demand-driven involvement by DFID with such space applications is support for the 2006 population and housing census in Nigeria. The bulk of DFID's investment in this project was on procurement of satellite imagery and related hardware and software for a GIS system that supports the census and can later be used for thematic mapping, including of poverty[3]. Another example of participation in the uses of space by African nations is provided by the UK-led Disaster Monitoring Constellation (DMC).

9.5 The African development organisation NEPAD has increasingly become associated with the space interests of Algeria, Nigeria, Libya, South Africa, Gambia and Senegal. These nations already recognise the potential of space to deliver rapid improvement in communications infrastructure. There is now competition among these countries to take a regional economic lead in northern, central and southern Africa. Space offers a disruptive opportunity to bypass missing or outdated infrastructure and a focus for development of much needed scientific and commercial skills.

9.6 Space is supporting the development of more sustainable African communities, providing a direct communications infrastructure, access to educational opportunities and enhanced environmental monitoring to deliver basic human rights of freedom from hunger and disease.

9.7 UK firms are well placed to supply those needs in Africa. The UK smallsat programme, supported by the DTI, has already enabled the UK to lead the way in building collaborations with African countries and other developing nations in disaster monitoring and humanitarian aid.

9.8 Sustainable development can also be facilitated using satellites. Simple educational aids such as self powered radios are now a reality but they require high power terrestrial transmitters. Self powered satellite radios are a sustainable, available alternative. A self powered satellite radio is green in three ways:

- The transmitting satellite is solar powered (no CO_2 emission) obviating the need to build expensive and power hungry terrestrial infrastructure
- Radios are self powered (no CO_2 emission)
- Educational content can create awareness globally of the need to protect the environment.

9.9 Satellite services represent a tremendous opportunity to focus long term education, communication and science developments direct to local communities in the UK, Europe, Africa and worldwide.

9.10 DFID has long been a user of satellite links to ensure access to internal networks for all DFID staff, working with the FCO. Substantial amounts are spent on comsat use every year. Furthermore, the Department's crisis prevention and response role (jointly with MoD and FCO) uses satellite mapping and high-resolution imagery as well as satcom and navigation equipment.

[1]Cf. HM Government, Implementation of the Commission for Africa recommendations and G8 Gleneagles' commitment on poverty. The UK contribution, March 2006.
[2]Cf. Meeting the Challenges of Climate Change in Africa, speech by DFID's Chief Scientific Adviser Sir Gordon Conway in Moshi/Tanzania on 23/1/2006; How UK Space is helping to shape Africa's future, Parliamentary Space Committee Briefing Note, April 2006. For background, cf. James Williams, Sustainable Development in Africa: Is the Climate Right? IRI Position Paper, Columbia University, 2005.
[3]Cf. the list of DFID Nigeria Programmes on the DFID website.

Conclusions and Recommendations

Wealth creation through high added value, high tech, science driven products and services

Increasing the reach of innovation and science

Enabling world class UK science

Increasing the effectiveness of UK key policy issues

Increasing trade opportunities with India and China

The Case4Space studies show that:-

10.1
- **Space technology,** services and derived applications are **delivering benefits to the citizens of the UK**
- **UK space industry contributes** significantly to growth of the UK's **knowledge, skills and high value added economic activity**
- **Previous Government and industry decisions are sound** and have produced a vibrant, competitive manufacturing and innovative services industry, generating real added value to the UK.
- **Investment through ESA produces leverage** which enables and maximises UK achievements in wealth creation, science and public service development.
- The UK along with the rest of the world is becoming **increasingly dependent on satellite infrastructure.**
- **Global space markets are growing** and the **UK can increase its share**, bringing major benefits to the UK and **helping Government tackle** the **critical challenges** for this century.
- The impact of satellite technology an the current asymetric security and defence is huge.

10.2 The **UK space industry will continue to strive** to capitalise on these opportunities and to increase its share of the expanding market; but continued **high levels of investment by industry and capital markets** will only be sustainable, in the face of competitive pressures from developed and emerging economies such as China and India, in conjunction with **complementary investment by Government.** This will enable UK space to develop the next generation of disruptive technologies in advance of those competing economies focusing on:
- application and service development
- cost reduction and capacity building
- sophisticated satellite payloads (especially advanced telecommunications)
- freeing up markets through appropriate approaches to regulation
- innovative financing strategies and high returns
- and smallsats.

10.3 Government can help facilitate investment and demand driven business generation that will bring excellent returns to the UK. It is vital to the future commercial success of UK industry that the chain: - national investment - ESA collaborative development - UK led commercial exploitation - be maintained and enhanced. The strength of a national programme significantly influences the return on investment in ESA, enabling the UK to influence the definition of ESA projects and permitting the UK to obtain key roles. It also secures IP for future commercial exploitation.

The role of Government is fivefold:

10.4
- **Enabler** of world class UK space, planetary and Earth sciences through UK and ESA science and EO programmes.
- **Risk reducer** for disruptive technology through ESA and national technology programmes.
- **Facilitator** and stimulator of knowledge transfer, innovation partnerships and the use of space technology and services to provide cost effective solutions to support policy implementation, in areas such as transport management, environment and security.
- **Investor** at seedcorn stage, jointly with industry, to enable capital markets to invest larger sums to develop major wealth creation opportunities.
- **Regulator** able to stimulate applications and free, competitive markets through appropriate standards and legislation.

10.5 Recovery of investments to previous levels are essential but modest increases starting now can place the UK as market leader in growing sectors and stimulate real wealth creation in the downstream service and application markets.

Conclusions and Recommendations

"We in government recognise that to support manufacturing achievement, we have a role to play...
Success does not happen by accident. It happens by design."

Prime Minister,
the Rt Hon
Gordon Brown MP

Recommendations:

10.6 The Case for Space has led UK Space to distil 8 key recommendations to ensure the UK grows its global market share over the next 5 years.

10.7

TOP 8 RECOMMENDATIONS

1. Industry and Government to step up the funding of the advanced telecoms R&D programme (ARTES) to £30m each per annum for 5 years to ensure the UK not just sustains but leads the market in disruptive technology.
2. Create a national satellite Research and Technology fund to drive innovation and risk reduction. A minimum annual programme budget of £20m per annum is needed to further improve the UK return on European investments, to include a provision for engaging with ESA's technology programmes in areas of national interest.
3. UK Government should press for inward investment from ESA to establish an ESA Applications Centre in the UK (potentially on the Harwell Innovation Campus) to further improve UK's leading role in service and application development.
4. The leverage in science and Earth observation programmes by investing in ESA should be formally acknowledged by Government and budgets should reflect a GDP based contribution as the norm. This should include full GDP contributions to both GMES and Aurora.
5. Policy implementation across departments should be reviewed at a high level to improve decision making and the UK regulatory environment to ensure a more effective user-based space strategy.
6. UK should break the total dependence on foreign satellite intelligence. A smallsat demonstrator SAR is recommended as a first step.
7. The importance of retaining sovereignty over key skills in military satellite technology should be fully recognised in the Defence Industrial Strategy and a research and technology programme should be initiated to fund small demonstrators and risk reduction activities ahead of major military programmes.
8. Industry and Government must intensify knowledge transfer to applications and service sectors and promote awareness to user departments.

10.8 In civil and defence areas, 2006 and 2007, represent decision points for the UK in space. Other nations have recognised the link between satellite technology and both wealth creation and policy implementation. Increased funding programmes have begun, particularly in India, China, Italy and Spain.

It is clear that space can realise its potential to contribute to solving many of the problems underlying the principal challenges now at the heart of UK Government's future policies, including:

- dealing with the increased pace and reach of technology in our economy and daily lives
- dealing with the increased cross-border economic competition and addressing opportunities from emerging markets such as China and India
- addressing the threat of international terrorism and global conflict; and
- evaluating and monitoring the effects of manmade pressures on natural resources and global climate.

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