House of Commons

Science and Technology Committee

Satellites and space

Third Report of Session 2016–17

HC 160

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Science and Technology Committee

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Summary

The dawn of the Space Age, from the launch of Sputnik 1 to the Apollo 11 moon landing, was one of the defining periods of the twentieth century. Human space exploration advanced the frontiers of science, yet it also provided a new perspective on humanity's place in the universe, fuelling scientific curiosity and inspiring a generation. While such activities may seem remote from everyday life, they played an integral role in the development of space technologies, many of which we now rely on: global positioning systems, for example, form the backbone of our emergency systems, while Earth observation satellites allow us to forecast the weather, and understand our climate, with increasing accuracy.

Space has also delivered important benefits to the UK economy. In 2012–13, the UK space economy generated a turnover of £11.8 billion, directly employed over 35,000 people and had delivered year on year economic growth rates of around 8% over the previous decade. We found an ambitious sector poised for even greater success, particularly in the field of small satellites, where we are recognised as a global leader.

The industry's target to grow the UK's share of the global space market from 6.5% to 10% by 2030 is highly contingent upon expanding the use of 'space-enabled services' by business and by the public sector. Achieving this target could deliver billions of pounds worth of new exports and up to 100,000 skilled jobs. But there is a lack of awareness of the ways in which satellite data can be used by bodies that sit outside of the traditional space sector. This is compounded by the inward-looking nature of the UK space and satellite industry, and its long-term failure to engage with other sectors. The Government, as well as local authorities, could be doing far more to stimulate awareness and growth through applying space-enabled services to help achieve effective and efficient policy delivery. The Space for Smarter Government Programme needs more resources so that it is able to work with Government departments to establish a cross-Government roadmap for using satellite data and developing space services.

The crisis in digital skills, identified in both our *Big data dilemma* and *Digital skills crisis* reports, is also apparent in the UK space and satellite sector, with witnesses highlighting it as a factor that may prevent the industry from reaching its ambitious growth targets. We agree with the Minister that Major Peake's Principia Mission has inspired the nation, and will have done much to encourage young people to think about pursuing a career in STEM. Relying on the inspirational value of the mission, however, is insufficient to tackle the magnitude of the skills crisis facing the sector. It should be a call to arms, not a cause for complacency. Now is also the time to address the missing piece in the UK's space ambitions and establish an expanded national space programme, alongside our contributions to the European Space Agency.

In other areas, the Government is forging ahead and attempting to place the UK in the vanguard of the next leap forward in space technology—the development of re-useable, commercial space planes. It has plans to establish a UK spaceport and in 2013 it announced an investment of £60 million in the British company 'Reaction Engines' and its 'SABRE' rocket engine, which is designed to be used in space planes. This was a

bold decision, but it has not been followed by solid action. The technical requirements for the spaceport are narrow and risk limiting its use and value to industry. We ask the Government to set out the rationale, and evidence, for its current proposal.

Direct Government investment is an important element of the space and satellite funding landscape and it is vital that funds reach the intended recipient in a timely fashion. None of the £60 million promised by the Government had reached Reaction Engines by the time we took evidence from them in February 2016. The Government seems to have fallen short of the professional standards of investment that we would expect.

1 Introduction

1. As Major Tim Peake prepared for his launch to the International Space Station in December 2015, the Government published its first ever *National Space Policy*.[1] Commenting on the document, the Business Secretary, Sajid Javid MP, remarked that while, historically, the UK had not "been a major player in space programmes" the *National Space Policy* would "change that because, in the words of my hero Mr Spock, to do anything else would be highly illogical."[2]

2. Much has already been achieved by the UK space and satellites sector. Over the past six decades, the UK has designed, built, launched and operated spacecraft. In 1962, Britain became the third nation, after Russia and the United States, to launch a satellite—Ariel 1. Today, we have an enviable reputation as an internationally-leading supplier and operator of small satellites. Our space scientists and engineers are world-class and have had a global impact, advancing our knowledge and understanding of the universe through their participation in a wide range of projects, including the recent Rosetta programme and the forthcoming ExoMars mission.

3. Though such activities may seem remote, space technologies have become integral parts of everyday life: communications satellites allow radio, television and telephone transmissions to be sent live, anywhere in the world; navigation satellites form the backbone of our emergency, aviation, and logistics systems; while Satellite-based Earth Observation enables us to gather, almost instantaneously, vast amounts of data about the planet's physical, chemical and biological systems—data which meteorologists, and those studying environmental change, rely upon. All of which has a tangible, positive impact upon the quality of our lives and the UK economy.

4. The 'space economy' encompasses a range of activities, from 'upstream' companies that manufacture, launch and operate satellites and launch vehicles, to the 'downstream' organisations that "make use of the signals and data supplied by these space assets to develop value-added applications", such as meteorological services.[3] In 2012–13, the UK space economy generated a turnover of £11.8bn, an increase of 4.1% on the previous year, while directly employing over 35,000 people.[4] According to the *National Space Policy*, the sector has delivered year on year economic growth rates of around 8% over the last decade.[5]

Our inquiry

5. Despite a distinguished history, excellence in R&D and innovation, and impressive economic growth figures, there has been a tendency for those involved in the UK space sector to be unduly modest about its genuine, and often ground breaking, achievements. One of the major challenges now facing the sector is a general lack of awareness, both that the UK has a well-established space sector, and that space and satellite technologies have the potential to address some of the 'Grand Challenges' we face. The *National Space Policy* reaffirms the Government's support for the industry's ambitious target to grow its share of

1 HM Government, National Space Policy, December 2015
2 "National Space Policy: science fiction into science fact" UK Space Agency News Story, 13 December 2015
3 ibid para 2.1
4 London Economics, The Case for Space 2015, July 2015, paras 3.1 and 5.3
5 HM Government, National Space Policy, December 2015, p 7

the global space market from 6.5% to 10% by 2030.[6] By today's estimates, this would lead to a UK sector with £40 billion per annum of space-enabled turnover.[7] Satellites is also one of the 'Eight Great Technologies': technologies in which the Government anticipates that "the UK is set to be a global leader".[8]

6. In light of these targets, and the Government's renewed emphasis on space and satellites, we decided to examine the opportunities for innovation and growth across the sector, as well as the potential roadblocks along the way. In doing so, we have followed up on our predecessor's examination of the *Work of the European and UK Space Agencies* in 2013. The UK Space Agency was established in 2011 as an executive agency, sponsored by the Department of Business, Innovation and Skills, with responsibility for all strategic decisions on the UK civil space programme. We hope that our current inquiry will inform the UK Space Agency's preparation of its forthcoming Civil Space Strategy.

7. In December 2015, we announced our inquiry and sought submissions addressing the following points:

a) What satellite-based capabilities should the Government particularly support—telecommunications, navigation, earth observation, space science, or others—and how?

b) What steps should the Government be taking to build markets for both new satellites and the 'space services' that they provide (such as space-based internet services or high resolution imaging)?

c) What is the impact of the current UK regulatory environment on growth in the satellites and space sector? Is it conducive to new players, such as SMEs and start-ups, entering the market? Has the regulatory environment kept pace with innovations in satellite/space technologies?

d) What mechanisms are needed to encourage investment in UK space and satellite technology, and improve access to finance?

e) Is the Government striking the right balance between national and European/international endeavour?

f) What are the key challenges facing the Government and industry in developing and implementing new space capabilities and services? What are the technical barriers to further growth in the sector, including the lack of a UK launch capacity?

8. We received 45 written submissions and took oral evidence from 17 witnesses from a variety of backgrounds including:

- academics;
- space and satellite multinationals and SME's;
- officials from the UK Space Agency, the Satellite Applications Catapult, Ofcom and Ordnance Survey;

6 ibid
7 Space IGS, Space Innovation and Growth Strategy 2014–2030, Space Growth Action Plan, November 2013, p 4
8 HM Government, Eight Great Technologies infographic, October 2013

- Defra Chief Scientific Adviser;
- the Government, represented by Joseph Johnson MP, Minister for Universities and Science, Department for Business, Innovation and Skills (hereafter "the Minister").

We also received a video message from Major Tim Peake on the International Space Station (see Chapter 2 and Appendix). We would like to thank everyone who contributed to the inquiry. Chapter 2 considers where innovation and growth in the UK satellite and space sector may come from and the extent to which opportunities are being capitalised upon.[9] Chapter 3 identifies some of the potential barriers to growth, while Chapter 4 looks to the future and the potential for a UK national space programme.

9 Science and Technology Committee, Fourth Report of Session 2013–14, Work of the European and UK Space Agencies, HC 253

2 Innovation and growth

9. This chapter sets out where there is scope for innovation and growth in the UK space and satellite sector, focusing in particular on small satellites, space-enabled services and the potential establishment of a UK spaceport. It also considers how these opportunities are being capitalised upon.

Small satellites and satellite constellations

10. The United Kingdom is a recognised leader in the development of satellites—especially small satellites—for navigation, earth observation and communication purposes.[10] 'Small satellites' is the overarching term used for those satellites with an in-orbit mass of less than 500 kg. They can range in mass from 100–500kg ('mini-satellites'), to 1–10kg ('nano-satellites') to less than 100g ('femto-satellites'). Small satellite platforms can also facilitate 'constellation architectures'—a group of satellites working together.

11. Growth in the small satellite market is strong. In 2013, 92 satellites weighing between 1–50kg were launched globally.[11] The space consultancy firm Euroconsult has forecast that over 500 small satellites will be launched between 2015 and 2019, with a total estimated market value of $7.4 billion; a 66% increase on the number of launches over the past decade.[12] Growth, however, is contingent upon reliable, low-cost access to space. Richard Peckham from Airbus noted that one of the impediments to growth facing small satellite companies was the ongoing challenge of securing a low-cost launch slot. Currently, a small satellite provider has to 'hitchhike' on a launch for a bigger satellite.[13] Airbus described this arrangement as placing the smaller, secondary payload at "the mercy of the main customer":[14]

> If somebody is going to launch a two-tonne satellite and you want to put your 100 kg on it, you are reliant on when that goes […] If it gets delayed because the programme of the main guy paying for the launch is delayed for some reason, you are stuck.[15]

12. Several of our witnesses stressed that the UK would benefit from establishing its own launch capability, potentially in the form of a 'UK Spaceport' which we discuss further in paragraph 27. According to the Royal Academy of Engineering, a spaceport could "catalyse the market for low-cost access to space, hand-in-hand with the development of smaller satellites that could be launched from the spaceport".[16]

13. Small satellite providers were broadly supportive of such a move.[17] Dr David Parker from the UK Space Agency reported that SMEs, like Clyde Space, had told the Agency that "the opportunity to have independent access for putting small satellites into space could make good business sense".[18] Ruy Pinto from Inmarsat, however, was less convinced that a

10 See, for example, ADS (SAT0031); Satellite Applications Catapult (SAT0013)
11 Elizabeth Buchen, Dominic DePasquale, 2014 Nano / Microsatellite Market Assessment, SpaceWorks, 2014
12 "510 Smallsat Launches Planned Over Next Five Years", Euroconsult press release, 26 February 2015
13 Q104
14 Airbus Group UK (SAT0016)
15 Q104
16 Royal Academy of Engineering (SAT0044)
17 Surrey Satellite Technology Ltd (SAT0011); Q125
18 Q28 [Dr Parker]

UK spaceport was essential to spearhead growth in small satellites. He stated that "having a regulatory regime that incentivises the manufacture of small satellites" was "more important than having a spaceport".[19] We discuss the space regulatory environment in detail in Chapter 3.

Space-enabled services and data

14. In addition to designing and developing new satellite technology, witnesses emphasised that capitalising on downstream 'space-enabled services', made possible by using satellite data, presented considerable growth opportunities. Direct-to-home satellite television is one of the most well-known, and well-used, satellite applications, though others are emerging.[20] Surrey Satellite Technology highlighted how Earth observation data was increasingly being used to assist with "flood modelling and response, maritime surveillance, environmental and agricultural monitoring, natural resource assessment" as well for security and defence purposes.[21]

15. *Vision 2030*, produced by the Satellite Applications Catapult, outlines how the application of these satellite-based services could become increasingly essential to our day-to-day lives in the near future. Examples from *Vision 2030* are outlined in Box 1 below.

1) Space technology could deliver increased airspace capacity, and lower airline operating costs, through aircraft using hyper-accurate navigation and weather data to plot optimal routes. Airports would also be better able to schedule arrivals and turn-arounds.

2) Competitive commercial meteorology providers could use advanced sensors in space to deliver accurate short and long-term forecasts for route mapping, so that cargo being transported to port by land now arrives at precisely the right time for loading on board the designated ship.

3) Satellite data could also power precision farming techniques, such as crop growth monitoring and disease prediction, improving yields, reducing the use of fuel and fertilisers, while also making crop shortfalls more manageable thanks to early warnings.

4) The UK's lead in smart, space-based radar for maritime surveillance has the potential to be used to ensure that endangered fish stocks are restored, illegal fishing is combated and global ocean reserves are protected for future generations

5) Further afield, broadband from space could transform connectivity and trade in rural locations and in developing nations.

Satellite Applications Catapult, Vision 2030: A world empowered by space (July 2014)

19 Q105
20 London Economics, The Case for Space 2015, July 2015
21 Surrey Satellite Technology Ltd (SAT0011); see also UK Space Agency

16. Analysis undertaken for the *Space Innovation and Growth Strategy 2014–2030* (a strategy produced by a team drawn from industry, academia and Government) indicated that the highest growth space markets over the next two decades would be in "space-based services and applications using space data, services and infrastructure".[22] Based on this market analysis, the Strategy, when it was published in 2013, recommended capitalising on "high-value priority markets", such as maritime surveillance, and satellite broadband, in order to "deliver £30 billion per annum of new space applications by promoting the benefits of Space to business and Government and engaging service providers".[23] Indeed, this was the first recommendation made in the Strategy.

17. Encouraging the Government and the public sector to use satellite-derived services and data also formed part of the *Civil Space Strategy 2012–2016,* a separate strategy produced by the UK Space Agency. The Agency stated that it would:

> support the development of 'smarter', more efficient government through the use of space data by providing strategic leadership, and by acting as the centre of expertise for government departments; working with them to identify applications and translate their needs into requirements for the space industry.[24]

18. Much like our predecessor Committee in 2013, we heard that while the UK space sector had good intentions in this area, it remained some way off reaching its goal of capitalising upon the space services market. This is due to a number of interrelated problems. First, we heard that UK growth in space services is being held back by a lack of awareness in companies outside of the traditional space sector of the ways in which satellite data can be used. As Professor Barstow from the Royal Astronomical Society explained, these are companies that "do not see themselves as being in the space business" and "do not know they will be able to benefit from the space sector"[25].

19. Raising awareness, however, presents a second challenge. We heard evidence that the satellites and space sector had traditionally been inward-looking and had not readily engaged with other industries. The *Space Innovation and Growth Strategy 2014–2030* clearly states that the "greatest challenge" facing the space industry is for it "to become more outward looking".[26] As Ruy Pinto from Inmarsat explained, space was "one of those industries that, frankly, loved to talk to one another. We had conferences and we just went round in circles, rather like people saying goodbye at the end of a party".[27] He added, however, that this outlook was changing:

> If we are to deliver on all the strategies and the growth targets we set ourselves, we have to open up and talk to outsiders, and bring in the supermarkets, retail chains, the teaching industry and the airline and training industries […] There is realisation that you have to look outside the sector.[28]

20. The Satellite Applications Catapult was identified as having an important role to play in raising awareness, so that 'outsiders' started:

22 Space IGS, Space Innovation and Growth Strategy 2014–2030, Space Growth Action Plan, November 2013, p 7
23 Ibid, p 10
24 UK Space Agency, Civil Space Strategy 2012–2016, 2012, p 18
25 Q82
26 Space IGS, Space Innovation and Growth Strategy 2014–2030, Space Growth Action Plan, November 2013, p 7
27 Q77 [Ruy Pinto]
28 ibid

> to realise that space is not the high-cost, high-risk, long-timescale activity they have been brought up to believe it is, but that there are services, capabilities and datasets available for them to use now that can very quickly deliver value to their business.[29]

UKspace, the Satellite Applications Catapult and the Royal Astronomical Society also suggested that more attention needed to be focused on better understanding the requirements of 'end users' of space services so that applications could be tailored to their needs.[30]

Government use of space services

21. Our witnesses emphasised that using space-enabled services was an area where the Government should be leading by example. In 2013, our predecessor Committee called on the Government to "do more to aggregate its own demand for space-derived services".[31] The *National Space Policy* states that the Government is committed to driving:

> the use of innovative services from space where they are the most cost effective solution to improve public services through coordination across departments and in partnership with the wider space sector.[32]

We received mixed evidence, however, about whether cross-government co-ordination was occurring. According to the Satellite Applications Catapult, "expertise and use of satellites across government" remained "fragmented and (often) duplicated". They told us that:

> If the government were to aggregate demand, and centralise procurement of satellite services (including police forces and local authorities), then it would be able to reduce costs and act as a 'launch customer' for future satellite services, which would build capacity and capability for UK companies, all with very high export potential.[33]

On the other hand, the UK Space Agency highlighted that a "cross Government Earth Observation Working Group" had recently started looking at the "barriers to use of satellite data"[34], and that establishing "what could be done to aggregate demand better" across Government was a piece of "ongoing" work.[35]

22. The Department for Environment, Food and Rural Affairs (Defra) was singled out as a "positive champion" for putting space services at the heart of its policy delivery.[36] In December 2015, it published a *Roadmap for the use of Earth Observation across Defra 2015–2020*, setting out how satellite data could be exploited by the Department to meet its "policy and operational needs".[37] The UK Space Agency hoped that Defra would be "a

29 Q5 [Stuart Martin]
30 UKspace and techUK (SAT0020); Satellite Applications Catapult (SAT0013); Royal Astronomical Society (SAT0014)
31 Science and Technology Committee, Fourth Report of Session 2013–14, *Work of the European and UK Space Agencies*, HC 253, para 19
32 HM Government, National Space Policy, December 2015, p 8
33 Satellite Applications Catapult (SAT0013)
34 UK Space Agency (SAT0042) para 17
35 Q187
36 Q5 [Dr Parker]
37 Q5 [Dr Parker]; Department for Environment, Food & Rural Affairs, Roadmap for the use of Earth Observation across Defra 2015–2020, December 2015, p 3

trail-blazer for other Departments" though, at the time of writing, no other, equivalent, Departmental, or cross-Government, roadmap existed.[38] Professor Ian Boyd, Chief Scientific Adviser at Defra, emphasised the importance of the cross Government Earth Observation Working Group, which was "in the process of developing its conclusions", but noted that, "at this stage, we would not call the next stage a road map".[39]

23. Professor Boyd was also clear that it would have been "extraordinarily difficult" for Defra to have got as far as it had without the support of, and funding from, the "Space for Smarter Government programme" (SSGP).[40] The UK Space Agency described the SSGP as a "partnership between the UK Space Agency and the Satellite Applications Catapult [that] is working with industry and academia to help develop applications and services that enable public sector bodies to better fulfil their obligations".[41] Established in 2014 with a budget of £700,000, Dr David Parker from the UK Space Agency noted that the SSGP's budget had been increased to £1.5 million for "the current financial year" (2015–16). The Agency's plan, he explained, was to:

> increase [the budget] again in the coming year. That is being driven by individual departments coming with their demands and requirements and linking them to the Satellite Applications Catapult with its technical expertise to help them with their problems.[42]

24. The UK Space Agency received £370 million from the Government for the 2015–16 financial year,[43] so the SSGP's budget represents approximately 0.4% of the UK Space Agency's overall budget for 2015–16. It is questionable whether this level of funding matches the clear emphasis placed by the *Space Innovation and Growth Strategy,* as well as by the UK Space Agency and the Government, on growing the 'downstream' space services market.

25. **Government and local authorities could use space-enabled services far more to help them to achieve effective and efficient policy delivery. Slow progress in this area, however, has been compounded by the inward-looking approach taken by the space and satellite sector, which has failed to engage with a broad range of stakeholders. The Space for Smarter Government Programme (SSGP) provides a means to remedy this situation. It has successfully worked in partnership with Defra to ensure that the full potential of satellite data will be playing its part in helping the Department to deliver its policy objectives. Other Government departments, however, are trailing behind. The modest resources currently attached to the SSGP do not match the clear emphasis placed by the Space Innovation and Growth Strategy, the UK Space Agency, and the Government, on growing the space-enabled services market. The lack of a cross-Government roadmap for space services also presents a significant barrier to future progress.**

26. ***We recommend that the remit of the Space for Smarter Government Programme is broadened so that it is able to work, in conjunction with Government departments, to establish a cross-Government roadmap for using satellite data and developing space***

38 Q5 [Dr Parker];
39 Q218
40 Q214 [Professor Boyd]
41 UK Space Agency (SAT0042) para 18
42 Q189
43 PQ 26968 [on Space Technology: Finance] 22 February 2016

services. The roadmap should identify areas where the application of such services could help the Government deliver its policy objectives more effectively and where it would benefit from aggregating demand to reduce costs. This expanded remit must be supported by adequate resources.

Establishing a UK Spaceport

27. The *National Space Policy* states that the "Government will enable access to new space markets where they offer significant advantages to UK space businesses" and that it has committed to establish a spaceport in the UK by 2018 for commercial spaceplane operations.[44] According to the Government, a spaceport will provide "a focus for regional and international investment for growth" while also "establishing the UK as a leader in the rapidly-expanding space market".[45]

28. By March 2015, five potential locations for a spaceport had been identified: Campbeltown, Glasgow Prestwick and Stornoway in Scotland, as well as Newquay in England and Llanbedr in Wales. RAF Leuchars in Fife was additionally identified as a potential temporary facility by the Civil Aviation Authority.[46] At the time of writing, a decision on location had not been made. Several media outlets, however, reported that the UK spaceport "competition" had been "axed in favour of a licensing model", and that the Government now intended to "work with operators to develop viable business models at a range of locations across the UK, rather than at any one single location".[47] These reports followed the Queen's Speech on 18 May 2016 and the announcement of the Modern Transport Bill, which will bring forward legislation to "allow for the construction of the first commercial spaceport".[48]

29. The *Space Innovation and Growth Strategy* identified limits on "access to space" as a barrier to growth in the UK space sector. It stated that the ability of UK satellite companies to secure launch slots was decreasing, while launch costs were increasing "because the availability of low cost launch vehicles in Eastern Europe is diminishing".[49] There was some disagreement between those giving evidence to us, however, about whether the UK needed to establish a spaceport and whether doing so would address problems with launching satellites, particularly given its current proposed focus on commercial space flight.

30. The Royal Astronomical Society questioned whether the lack of a national launch capacity was "a major technical barrier to growth in the space sector, given the UK's access to and partnership in the ESA Ariane rocket programme".[50] In a similar vein, Avanti Communications Group, a satellite operator, stated that it did "not believe that the lack of a UK launch facility [was] necessarily a barrier to the growth of the UK space sector".[51] UKspace, in contrast, was supportive of the plans, on the grounds that:

44 HM Government, National Space Policy, December 2015, p 14
45 "Government paves way for UK spaceport", UK Space Agency press release, 15 July 2014
46 "Industry backs government's spaceport plans", Department for Transport, 3 March 2015
47 "UK spaceport competition axed in favour of licensing model", The Herald, 20 May 2016; "Government moves the goalposts in Newquay spaceport bid", Plymouth Herald, 23 May 2016
48 HC Deb, 19 May 2016, column 170 [Commons Chamber]
49 Space IGS, Space Innovation and Growth Strategy 2014–2030, Space Growth Action Plan, November 2013, p 14
50 Royal Astronomical Society (SAT0014), para 36
51 Avanti (SAT0026) para 8.1

> building of one or more UK-based spaceports has the potential to catalyse the market for low cost access to space, hand-in-hand with the development of smaller satellites that could be launched from the UK. In turn, this has the potential to boost UK competitiveness and catalyse new markets in space-enabled services. It will also reduce UK dependence on key facilities currently outside its control.[52]

31. The Department for Transport (DfT) is expected to publish a detailed technical specification of spaceport requirements, prior to inviting proposals. Though a presentation on *Emerging Technical Requirements for a UK Spaceport* was published by the DfT in November 2015, it stressed that:

> technical and other requirements for a UK Spaceport are […] subject to a number of factors and uncertainties that could cause them to change. No reliance should therefore be placed on any aspect of this presentation, and it should not be assumed the final requirements for a UK Spaceport will be as set out here.[53]

The presentation did state, however, that examining the potential for a UK spaceport to have a "vertical launch" capacity was "not in the scope" of its work.[54] Instead, the Government's plans were for a UK spaceport that would deliver a horizontal launch capacity, in anticipation of the successful development of suborbital space planes.

32. Though great strides have been made by a number of companies in developing space planes, the technology is unlikely to be operational in the foreseeable future, and is highly unlikely to be ready by 2018. Compared to civil aviation, commercial space plane technology is in its "infancy" and, according to a Government-commissioned review by the Civil Aviation Authority, "the standards of airworthiness for commercial aviation are not fully compatible with spaceplane technology".[55]

33. The focus on supporting only a horizontal, rather than horizontal and vertical, launch capacity, was a point of contention in the evidence we received. Surrey Satellite Technology favoured the development of "UK launch solutions aimed at lowering cost and improving schedule reliability" but was "supportive of a UK spaceport with a vertical launch capability and/or air launch capability".[56] Similarly, Discover Space UK, the organisation responsible for Campbeltown's bid for the UK spaceport, viewed the current UK plans as "too narrow" and imposing "unnecessary limitations on flight options and sector business opportunities".[57] Innovate UK recognised that while there had:

> been clear public consultation on a horizontal launch capability […] similar scrutiny is needed for a vertical launch capability and what balance of investment is needed in national rocket technology to make this viable […] this needs proper consideration and integration into the UK's growth ambitions.[58]

52 UKspace and techUK (SAT0020)
53 Department for Transport, Emerging Technical Requirements for a UK Spaceport, 6 November 2015
54 ibid
55 Civil Aviation Authority, UK Government review of commercial spaceplane certification and operations Summary and conclusions, July 2014, p 42
56 Surrey Satellite Technology Limited (SSTL) (SAT0011) para 20
57 Discover Space UK Ltd (SAT0005) para 2.2.d
58 Innovate UK (SAT0038) para 39

34. When asked if the Government's role was to fund a spaceport, or simply to facilitate it, the Minister replied that it was:

> much more the latter. We have always made it clear that this is primarily a commercial enterprise. Government's role is to make sure that there is an enabling regulatory environment and that we work through all the complex regulatory and technical issues that having a space flight capability involves.[59]

35. **Through its promotion of the establishment of a UK Spaceport by 2018, the Government has placed the UK in a prime position to take advantage of the next leap forward in space technology—the development of re-usable, commercial spaceplanes. The focus on a horizontal-only launch capacity, however, may be too narrow and risk limiting the use and value of a UK spaceport to the industry.**

36. ***Before publishing its final 'technical requirements' for a UK spaceport, we recommend that the Government sets out the rationale, with supporting evidence, for limiting the scope of the proposed spaceport to accommodating only the horizontal launch of suborbital flights. The Government should also explain how it is ensuring that the spaceport plans will be further refined to meet the needs of UK space and satellite businesses, and what it will do to ensure that the proposal attracts the necessary private investment.***

Legacy of Major Tim Peake's Principia mission

37. Almost 25 years after Helen Sharman became the first British astronaut in space, British ESA astronaut Major Tim Peake joined an elite cadre of men and women who have pushed the boundaries of mankind's exploration of space. Launching successfully from Baikonur Cosmodrome in Kazakhstan on 15 December 2015, Major Peake became the first UK Government-funded British astronaut to join the crew of the International Space Station (ISS). The UK Space Agency estimated that over 24 million watched the launch.[60]

38. Major Peake's Principia mission involved undertaking experiments that cannot be conducted anywhere on Earth. He also used the time leading up to the mission, as well as his months on the ISS, to inspire people, especially the next generation, and develop their interest in science. Our witnesses highlighted the success of this aspect of the mission. The range of educational outreach activities, available via the Principia mission website, is broad and engaging, from a national seed growing programme and fitness challenges to a coding competition using data from two 'Astro Pi' computers on the ISS.[61] UKspace noted that it demonstrated "the value that can be obtained, in terms of excitement and inspiration, from modest UK involvement in human space flight".[62]

39. There have also been numerous video and radio link ups with Major Peake by schools, colleges, universities and, indeed, by Parliament. On 2 April 2016, in a first for both the Science and Technology Committee and Parliament, Major Peake contributed to our inquiry evidence from on board the ISS. In a video, he answered questions from our Committee Chair and the Science Minister (a transcript of which is presented in an Appendix to this report). This formed part of the Royal Society of Biology's annual 'Voice

59 Q181
60 UK Space Agency (SAT0042)
61 http://www.principia.org.uk/
62 UKspace and techUK (SAT0020)

of the Future' event, hosted by the Science and Technology Committee in Parliament. [63] We would like to thank Major Peake, the UK Space Agency, ESA, NASA and the Royal Society of Biology for making this possible. Having done so much to raise awareness of the UK space sector, and inspire a nation, our witnesses stressed the importance of keeping the momentum going that has been generated by the Principia mission, "particularly in relation to inspiring young people to take up STEM subjects and careers" (a point we consider further in Chapter 3).[64]

40. **Major Tim Peake, the UK Space Agency, the European Space Agency, and countless others have, together, inspired a nation through their excellent educational outreach and public engagement work around the Principia mission. It is vital that this enthusiasm for space is harnessed and is used to foster an enduring public interest in the UK's space sector, and the opportunities it holds.**

41. ***We ask the Government to outline its plans to ensure that the legacy of the Principia mission continues to raise public awareness of the UK's leading role in the global space sector, while also inspiring the next generation of scientists and engineers, long after Major Peake returns to Earth.***

63 Voice of the Future is an annual event, held on the Parliamentary Estate, during which young scientists have the opportunity to question Members of the Committee, Government and shadow Government Ministers and the Government Chief Scientific Adviser on all aspects of science policy.

64 Airbus Group UK (SAT0016); see also Royal Aeronautical Society (SAT0028); Goonhilly Earth Station and the Aerohub Enterprise Zone in Cornwall (SAT0019)

3 Barriers to further growth

42. This chapter identifies where, how and why the growth of the UK space sector is being held back and looks closely at the importance of skills, finance and funding, and the regulatory environment.

Skills

43. Meeting the Government's target of increasing the UK's share of the global space market to 10% by 2030 is contingent upon a number of factors, not least having access to a ready supply of highly-skilled people to work in the sector, from engineers and mathematicians to data scientists and analysts. Witnesses were broadly optimistic about reaching the target but with one significant reservation. Skills shortages, and particularly a scarcity of engineers and data analysis skills, were repeatedly cited as factors that could prevent the sector reaching its growth potential.

44. In our recent report on the *Digital skills crisis* we highlighted "a pressing need" for high level specialist skills in data science and other disciplines. We recommended that the Government's forthcoming Digital Strategy address the gap between the digital skills that children and young people take into their working lives and the skills actually needed by the digital economy, and map public spending on digital skills against employers' priorities to help assess the effectiveness of Government measures in addressing the digital skills crisis.[65]

45. In the satellites and space sector, Professor John Remedios from the National Centre for Earth Observation believed that skills shortages were:

> certainly becoming a problem. If you are going to expand the community that includes the science and industrial base, there are lots of requirements for skilled people […] The amount of data we are getting is huge, and the ability to handle it is a big problem.[66]

For Andy Green from UKspace, skills were a "real crisis for the country". He highlighted the challenge of analysing the "masses of data coming from Copernicus[67] […] and making it work in the real world".[68] He feared the problem was "falling through the cracks" which, in turn, risked making it "harder and harder for small companies to start up and find the skills they need in the UK".[69] Skills shortages were also identified as a potential reason for the slow uptake of space services across Government and the public sector. As Professor Ian Boyd, Chief Scientific Adviser at Defra, explained:

> Very large amounts of data are available from satellites of a variety of different of types. […] The large volumes of data are a challenge in their own right,

65 Science and Technology Committee, Second Report of Session 2016–17, *Digital Skills Crisis*, HC 270

66 Q48 [Professor Remedios]

67 Copernicus is an Earth observation initiative, delivered by over 30 satellites, and headed by the European Commission in partnership with the European Space Agency (ESA).

68 Q41

69 Q41–42

> but the number of people who have the skills to be able to process those data and the private sector involvement to provide the tools those people need to process the data is taking a while to get going.[70]

We described the risks of such a data analytics skills gap in our *Big Data Dilemma* report earlier this year, as 'big data' reaches further into the economy. Those risks were concerned not just with the quality and security of data but with potentially missed economic opportunities.[71]

46. When asked how the Government intended to overcome the skills crisis, and deliver the skills needed in the space sector, the Minister acknowledged that it was "essential" to train "sufficient skilled engineers and ICT specialists to meet the rapid growth we are targeting for the sector and to make the most of the opportunities that data can provide".[72] He drew attention to ongoing initiatives, such as the appointment of a "national skills point of contact" at the UK Space Agency and the "Astro Pi project" in schools.[73]

47. Much emphasis has also been placed on the inspirational value of Major Peake's mission. The Minister was hopeful that this would have an impact across the UK "similar to the Apollo effect that the US managed in the 1960s, 1970s and 1980s" and would prompt a "real uptick in the numbers of people taking physics, maths and other subjects at higher levels".[74] Innovate UK, however, cautioned that if the UK was to make the "best use of the hoped for 'Apollo effect' on the back of Tim Peake's mission" it needed "to balance personal ambitions and dreams with attractive careers".[75]

48. **We were clear in our reports on Big Data and, most recently, Digital Skills, that the UK is facing a digital skills crisis. This crisis is already apparent in the space and satellite sector, where the need to process and analyse large amounts of data from satellites, and transform them into valuable insights, is a pivotal component of the Space Innovation and Growth Strategy. Without urgent action, data skills shortages could undermine, and potentially stall, the industry's progress towards its ambitious 2030 growth target. Existing initiatives, and the inspirational value of the Principia mission, are insufficient to tackle the magnitude of the problem.**

49. ***The Government should, as we recommended in our recent Digital skills crisis report, commit to addressing this crisis through a Digital Strategy published without further delay.***

Accessing finance

50. Another barrier to growth, identified by both space SMEs and larger companies, was access to finance and capital. As Patrick Wood from Surrey Satellite Technology explained, space tends to be perceived as a risky, long-term venture which can dissuade investors:

> Space is one of the areas where, if you are a new entrant or you have an idea that may not have maturity or is very innovative, people are naturally hesitant.[76]

70 Q197
71 Science and Technology Committee, Fourth Report of Session 2015–16, *The big data dilemma*, HC 468
72 Q191
73 Q191
74 Q191
75 Innovate UK (SAT0038) para 35
76 Q136; see also Q84

51. Witnesses observed that the risk appetite of investors was generally lower in the UK than in the US. According to Neil Ackroyd from Ordnance Survey, the investment culture in the US, where they are willing "to accept higher risk", is "radically different" from that found in the UK.[77] UKspace suggested that the different culture was linked to the source of the funds:

> Risk finance in the UK comes largely from funds investing on behalf of institutional or retail investors; they necessarily have to be more risk adverse than very high net worth individuals investing on their own account.[78]

52. To address part of this problem, an £83m venture capital fund for space has been established by Seraphim Capital. The fund is "based on a contribution from the British Business Bank alongside corporate and City investors" and is designed to "assist growing SMEs looking to further develop entrepreneurial space projects and applications".[79] Other witness drew attention to a range of concerted efforts, made by the space and satellite sector, aimed at shifting perceptions away from it being a 'risky venture'. The Satellite Applications Catapult, for example, explained how it meets organisations and businesses outside the space sector in order to "raise the profile of the sector […] and its potential to boost productivity and reduce costs".[80] Innovate UK also believed that the *Space Innovation and Growth Strategy* had "been a powerful forum for raising the profile of space as a commercially viable sector with impressive and attractive growth potential and heritage".[81]

53. **The Government, Innovate UK, the Satellite Applications Catapult and the British Business Bank have, by working with industry, helped to create opportunities for companies with a high growth potential to access much needed capital. While there is scope to improve access further, the establishment of the UK's first dedicated investment fund for space is an encouraging and important step in the right direction.**

Export finance

54. The ability to raise finance was described by Inmarsat as "only one aspect" of the 'finance problem'. One of the key issues facing the satellite industry was the need for significant upfront investment to fund the construction and launch of a satellite, "with a payback over many years".[82] It highlighted the assistance provided by the US Export-Import Bank "to fund this large capital bridge" with "lower than market interest rates with a long tenor".[83] Though UK Export Finance was identified as offering "this to some extent", Inmarsat maintained that it "has not been widely available for the space and satellite sector".[84] OneWeb also pointed to the need for a "strong UK Export Finance structure" in order to "effectively compete against those already existing abroad, e.g., EXIM (USA), Coface (France) and Export Development Canada (Canada)".[85]

77 Q217
78 UKspace and techUK (SAT0020)
79 UK Space Agency (SAT0042) para 26
80 Satellite Applications Catapult (SAT0013)
81 Innovate UK (SAT0038) para 23
82 Inmarsat (SAT0037)
83 ibid
84 ibid
85 OneWeb (SAT0036)

55. In its response to the *Space Innovation and Growth Strategy*, published in April 2014, the Government recognised that "a significant proportion of growth in the space sector must come from exports" and that "the development of a high level export promotion plan is vital in light of the [strategy's] £25 billion export target by 2030".[86] It is not clear, however, what progress has been made on producing and executing such an export plan.

56. ***In response to our report, the Government should provide details of its progress on developing an export promotion plan for space. This should include information on export finance initiatives that will assist the space sector and how these compare with our international space and satellite competitors.***

National demonstration programmes

57. One of the biggest barriers to entry to the space and satellite sector for SMEs was a lack of 'flight heritage' due to a dearth of flight opportunities. As Patrick Wood from Surrey Satellite Technology explained, "even if it is just a few components or a different type of material that they want to try, it is incredibly difficult for those types of companies to get those opportunities".[87] He added that potential customers would question the quality and feasibility of the space business' 'product', and thus be reluctant to invest, "unless [they] have actually flown some of the technology".[88]

58. Witnesses from both industry and academia therefore stressed the importance of national technology demonstration programmes as a means to bridge this innovation gap. Airbus was clear that "in-orbit demonstration, [could] only be provided by institutional missions (be they national, bilateral, or ESA, etc.)", adding that "Government support for these demonstration missions [was] essential to unlock the commercial markets".[89] The Satellite Applications Catapult similarly noted that accelerating:

> Innovate UK's In-Orbit Demonstration programme, delivered in partnership with the UK Space Agency, [would enable] UK companies to demonstrate their groundbreaking space technology to a global audience, thus unlocking export opportunities.[90]

59. Dr David Parker reported that Innovate UK was "evaluating the possibility of a further technology demonstration satellite".[91] We were therefore encouraged to receive additional evidence that Innovate UK and the Satellite Applications Catapult have very recently "commenced a new programme", based on CubeSats, to provide UK companies with demonstration opportunities.[92]

60. **A lack of flight heritage is a significant barrier that space and satellite SME's must surmount if their products are to become a commercial success. *Given the scale of this barrier, we recommend that additional resources are made available to Innovate UK, so that it is able to expand further its In-Orbit Demonstration programme.***

86 UK Space Agency, Government Response to the UK Space Innovation and Growth Strategy, 2014 – 2030, April 2014, p 10
87 Q135 [Patrick Wood]
88 ibid
89 Airbus Group UK (SAT0016)
90 Satellite Applications Catapult (SAT0013) para 9.2
91 Q174
92 Innovate UK (SAT0047)

Direct Government investment

61. On occasions, the Government has made strategic, direct investments in space and satellite companies. This display of confidence can 'prime the pump' and stimulate investment from other, non-Government sources. We heard from Mark Thomas, Managing Director of Reaction Engines, about one such example. In 2013, the Government announced a £60 million investment in Reaction Engines (REL) to help support the development of SABRE—the world's first air-breathing rocket engine. The announcement stated that the funding would be "staged over two years, £35m in 2014/2015 and £25m in 2015/2016".[93] According to Mr Thomas, however, the investment has yet to materialise:

> It took two and a half years to get the grant agreement signed, and three years later we still have not seen any of those funds flowing into the company. Potentially, it is a missed opportunity in that it has given our competitors an extra three years to try to find ways to beat our engine.[94]

62. REL subsequently wrote to us in March 2016 with further details of the delays. It highlighted that communication between the Department for Business, Innovation and Skills (BIS) and Reaction Engines had been sub-optimal which, it suggested, "appeared to prolong the process". According to REL:

> REL leadership was not given access to the decision makers within BIS who were responsible for setting the terms of the grant […] documents were given to REL without explanation and REL was unable to get access to individuals who were able to explain the thinking behind changes.[95]

REL also reported that "material changes were made to the conditions of the grant without warning or explanation" from BIS. This included a reversal of the Government's previous position:

> whereby REL was now informed that the £50m would not be approved until there was prior committed inward investment from an aerospace prime. The previous position of the Government was the reverse, as outlined by the Minister (" …our investment will help to prime the pump for further commercial investment to supply the remainder of the capital needed for full engine development"). No explanation was given for this change.[96]

63. Dr David Parker from the UK Space Agency, however, had a different perspective on the Agency's engagement with REL. He described "a process of helping the company understand the need to produce, first, a very coherent programme in steps".[97] When questioned on the delays, he told us that since it was "an R and D project under the Science and Technology Act […] we had to ensure that what we were doing remained compatible with the terms of the Act […] In addition, because it was a national project, we had to ensure that it met EU state aid rules."[98]

93 "Government to invest £60m in world's first air-breathing rocket engine", Satellite Applications Catapult press release, 16 July 2013
94 Q125
95 Reaction Engines Limited (SAT0046)
96 ibid
97 Q162
98 Q163

64. Such delays have had tangible consequences. The US publication *space.com* reported in March 2016 that the US Air Force Research Laboratory would shortly be unveiling novel "concepts based on Skylon space plane" technology, adding that the Laboratory had "been developing hypersonic vehicle concepts that use the Synergetic Air-Breathing Rocket Engine (SABRE)".[99] Avoiding 'losing' the technology to the United States was one of the initial reasons given by the Government for its investment in REL and SABRE.[100] This was reiterated by Dr Parker, who told us that the Government's "end goal was to secure this technology for the UK, not see it go abroad as has happened sometimes in the past".[101]

65. **Timely access to finance is vital if innovative UK companies are to reach their growth potential and break into the global space and satellite market. We are disappointed, therefore, to hear that the £60 million investment in Reaction Engines and its SABRE rocket, announced by the Government in July 2013, had not reached the company by February 2016. Delays of this nature risk blunting the competitive edge of nascent players in the sector by increasing the financial uncertainty that they face. We were particularly concerned to learn that material changes were made by BIS to the conditions of the grant without giving prior warning or explanation to Reaction Engines.**

66. **Direct Government investment is an important element of space and satellite funding and should be conducted to the highest professional standards. The Government, however, appears to have fallen short of these standards in its dealings with Reaction Engines.** ***We therefore ask the Government to explain, in response to this report:***

a) ***why it changed the conditions of the grant made to Reaction Engines almost two years after announcing the investment;***

b) ***why it estimated that the first £35 million would be made available in 2014/15 and did not foresee any delays that EU State Aid regulations might present;***

c) ***whether any other space and satellite SMEs have been affected by similar delays in direct Government investment reaching them; and***

d) ***the key lessons it has learnt from this project and what changes it will make to the conduct of any future direct investments in the UK space sector.***

Research funding

67. Gaps in research funding were repeatedly identified during the course of the inquiry as presenting a potential barrier to growth. At present, UK Research Council funding for space and satellites is split across many Councils, while other funds sit within the UK Space Agency and Innovate UK budgets. Witnesses stressed that projects often do not fall neatly under the scope of a specific Research Council, and the type of research it funds, thereby creating what UKspace described as "orphan areas".[102] This, in turn, can

99 'US Military Set to Unveil Concepts Based on Skylon Space Plane Tech', 3 March 2016, last accessed on 19.04.16 at: http://www.space.com/32115-skylon-space-plane-engines-air-force-vehicle.html

100 Speech to the UK Space Conference delivered by Rt Hon David Willetts MP, 16 July 2013

101 Q162

102 UKspace response to the Nurse Review of Research Councils call for evidence, April 2015

leave researchers struggling to identify and obtain funding. The University of Oxford, for example, described securing funding for basic research into space technologies as "difficult" because it "falls between the remit of EPSRC, NERC, STFC, and UKSA".[103]

68. Falling between Research Council remits can also mean that researchers are "bounced" from one Council to another. Researchers at the University of Glasgow found that "if they put in an application to EPSRC, they would be told it would be better to go to the UK Space Agency; if they put in the application to the Space Agency, they were bounced back again".[104]

69. Funding to enable researchers to take early stage ideas out of the laboratory, and into the prototype development and demonstration phase, was highlighted as particularly difficult to access. Professor Barstow from the Royal Astronomical Society, described the problem:

> At the moment we have a gap […] We have the STFC that funds basic research and the UK Space Agency that funds the building of space missions. The technology bridge between those two in terms of readiness is very hard to get across. We can start some basic research, but then we cannot find any money to translate it into capability that the space agency can then take to ESA.[105]

Professor John Remedios told us that there were "not enough joint academic-industrial programmes as opposed to one or the other" and that "pull-through from the research base" suffered as a result.[106]

70. These problems are not new. Sir Paul Nurse, in his 2015 review of the UK Research Councils, identified a need to establish "mechanisms to deal with cross-cutting issues such as the support of multi-disciplinary and inter-disciplinary research, Grand Challenges and the redistribution of resource between Research Councils".[107] He therefore proposed that "the partnership of the seven Councils making up RCUK should evolve into Research UK" in order to "strengthen Research Councils in the effective formulation of strategy, promotion of research, and engagement with their communities".[108] The Government subsequently committed to establishing 'UK Research and Innovation' (UKRI) which will bring together the seven Research Councils, Innovate UK and the research funding from Higher Education Funding Council for England (HEFCE). According to the White Paper, *Success as a Knowledge Economy*, published in May 2016, UKRI will "deliver" a:

> greater focus on cross-cutting issues that are outside the core remits of the current funding bodies, such as multi- and inter-disciplinary research, enabling the system to respond rapidly and effectively to current and future challenges.[109]

103 University of Oxford (SAT0010). The Research Councils referred to are the Engineering and Physical Sciences Research Council (EPSRC), the Natural Environment Research Council (NERC), and the Science and Technology Facilities Council (STFC).

104 Q193

105 Q89 [Professor Barstow]; see also Q99 [Richard Peckham]

106 Q71 [Professor Remedios]

107 Paul Nurse, Ensuring a successful UK research endeavour. A Review of the UK Research Councils, November 2015, p26

108 Ibid, p33

109 Department of Business, Innovation and Skills, *Success as a Knowledge Economy: Teaching Excellence, Social Mobility and Student Choice*, Cm 9258, May 2016

71. The funding gap problem was identified by a broad range of stakeholders. In its written evidence, the Satellite Applications Catapult highlighted "a gap around early-stage satellite-specific engineering, ICT and communications development, because the EPSRC does not support the space sector and STFC only funds space science".[110] When asked if that gap was being addressed, Mr Stuart Martin from the Catapult stated that he thought "there still [was] a gap".[111]

72. At a subsequent evidence session, however, Dr David Parker from the UK Space Agency, questioned the existence of a funding gap. He stressed that "just as we [the UK Space Agency] work very closely with STFC, NERC, and Innovate UK, there are no barriers to working with EPSRC at all".[112] He later assured us that if there was "a danger of something falling through the funder pores—the gap between organisations—we will look at it".[113]

73. **Basic research is integral to building a successful space economy. The vibrancy and success of the UK space sector has resulted in more excellent research projects requiring funding than there are funds available. There is, however, a more deep-seated, systemic problem; namely that, under the current research funding structures, some satellite and space-related research proposals fall between the remits of the different Research Councils, creating "orphaned areas" of space research. Projects should not miss out on research funding because of inflexible administrative boundaries.**

74. ***We are encouraged by Sir Paul Nurse's focus on establishing funding mechanisms to deal with cross-cutting issues in his review of the UK Research Councils. The Government must explain how the newly-established UK Research and Innovation, overseeing the UK Research Councils, Innovate UK and HEFCE research funding, will be structured to avoid perpetuating the damaging, cross-cutting funding gaps. We further recommend that representatives from the UK Space Agency are members of the Strategic Advisory Boards of the STFC and EPSRC, to help ensure a more comprehensive, joined up approach to delivering research funding for space and satellite science.***

Regulatory environment

Licencing and insurance

75. All UK operators of satellites, or other space vehicles, must obtain a licence from the UK Space Agency and take out third party insurance. The *Outer Space Act 1986* requires a party carrying out certain space activities to indemnify the Government. Until 2015, indemnity had to be provided on an unlimited liability basis. Section 12 of the *Deregulation Act 2015*, however, makes provision for the Government to limit a party's liability at €60 million. The Government has also waived Insurance Premium Tax on satellite launches. These changes have been warmly welcomed by the industry, with UKspace describing them as having helped "to create a level playing field for UK companies".[114]

110 Satellite Applications Catapult (SAT0013)
111 Q22
112 Q160 [Dr Parker]
113 Q194
114 UKspace and techUK (SAT0020)

76. Some witnesses told us, however, that the regulations had failed to keep pace with new trends in the sector, especially the growth of small satellites and satellite constellations, and that further reform was still necessary. Richard Peckham from Airbus Group described the current regulations as having been "written on the assumption that satellites were big things and you just launched one of them, and that was it. If you are looking to launch hundreds of small satellites […] you have to have a much more flexible approach".[115]

77. Several problems linked to licensing and insurance were raised. First, unlike other countries which only require insurance to cover the launch of a 'space vehicle' or satellite, the UK requires the operator to have insurance to cover all parts of the mission (pre-launch, launch and in-orbit insurance). The Mullard Space Science Laboratory considered the current regulations to be particularly prohibitive for small satellites on the grounds that having "full insurance for in-orbit operations [generates] a higher cost for building and launching nano-satellites registered in the UK". It added that this requirement also "slows and reduces UK participation and utilisation of this growing format of space technology".[116]

78. Other witnesses focused on the level of the operator's liability. Michael Johnson, an experimental physicist working on small satellites, stressed that the annual insurance premiums required to cover the €60 million of third-party liability insurance were "many times the cost of building and launching a basic CubeSat or other small spacecraft […] making it completely uneconomic to license small British spacecraft".[117] The Satellite Applications Catapult also highlighted that the "€60 million requirement is currently per satellite, takes no account of satellite size or value and is particularly onerous for satellite constellations".[118]

79. Witnesses commended the UK Space Agency for its ongoing efforts to tackle these problems. Patrick Wood from Surrey Satellite Technology reported that he had seen "a huge amount of work by the UK Space Agency to try to simplify" the regulation and licensing. Ross Marshall from Clyde Space agreed that the "UK Space Agency [was] supportive and [was] making big steps" in this area.[119] According to the Minister, the Government is currently looking at whether it can:

> put in place a traffic light system whereby small satellites meeting certain launch, orbit and technical criteria can be fast-tracked to licensing. We are reviewing how in-orbit operations insurance can be waived completely for any such fast-tracked small satellites; how insurance requirements can be aggregated for constellations of satellites to support these new and emerging trends within the sector; and aspects of how we charge for licensing.[120]

80. Concerns were raised by industry that the Space Agency's proposed traffic light system, aimed at simplifying the licensing of small satellites, risked making it cumbersome and complex. Ruy Pinto from Inmarsat welcomed the attempt to make satellite launches more affordable but warned against "over-complicating" the process:

115 Q109
116 Mullard Space Science Laboratory (SAT0034) para 3.1
117 Michael Johnson (SAT0007); see also Q143
118 Satellite Applications Catapult (SAT0013)
119 Q141
120 Q177

> We should make it easier to launch satellites and further lower the insurance requirements […] We run the risk that, with the laudable aim of making it simpler, we make it even more complicated for a small company to launch a small satellite […] I think that €60 million is too much and it will stifle small satellites. Just lower it […] The risk is minimal. We are, quite frankly, over-regulating on that front, both for small satellites and for bigger companies.[121]

81. Ross Marshall from Clyde Space went further, describing the traffic light approach as an "intermediate step" that he did not think was necessary: "You can go straight to the end goal. I do not see any need for liability insurance, certainly for small satellites."[122] He believed that, if the UK Government took the liability risk on board and managed it, the UK "would then attract a lot of businesses based on that. A company that builds satellites in Glasgow with us regulates them through the US for that reason."[123] Patrick Wood from Surrey Satellite Technology was more circumspect, noting that "at the end of the day, we are launching into space, so we have to be able to justify that we have done all the work that we would want to do to minimise the risk to the UK Government".[124]

82. At present, the draft regulation recommendations published by the UK Space Agency refer to the specific case of CubeSats (a type of nano-satellite), rather than small satellites more broadly.[125] To feed into this "regulatory work", Dr Parker stated that the UK Space Agency was also conducting "some mathematical modelling to understand the risks" associated with small satellite and satellite constellations, including the ability to monitor and track them.[126] This is particularly important when they reach the end of their 'useful' life and become space debris. Given the prospect of constellations of both large and small satellites, UKspace urged that "adequate arrangements are made for management of satellites and space debris".[127] Dr Parker acknowledged that "more needs to be done"[128] in this area, though Patrick Wood of Surrey Satellite Technology stressed that it was "down to not just the UK but all the nations in space to behave responsibly".[129]

83. **The current licencing and regulatory regime has not kept pace with innovations in the space sector. While we welcome the changes made under the Deregulation Act 2015, the regulatory status quo risks stymieing a key growth area for the UK space sector, namely small satellites and constellations. The UK Space Agency (UKSA) is beginning to address industry's concerns. Progress has been slow, however, and focused on the specific case of Cubesats, rather than small satellites more generally. It is vital that, while the UKSA maintains its reputation as a responsible regulator, it also does not adversely impede innovation and growth in the sector. We are concerned that the UKSA's draft regulatory proposals, as they currently stand, risk complicating the process when the intention is to simplify regulation and make it more proportionate.**

121 Q111–112
122 Q141 [Ross Marshall]
123 Q143
124 Q141 [Patrick Wood]
125 UK Space Agency, Draft: Cubesat regulation recommendations
126 Q34
127 UKspace and techUK (SAT0020)
128 Q34
129 Q153 [Patrick Wood]

84. ***We recommend that the Government, in response to this report;***

a) ***clarifies whether its published draft regulations are intended to apply only to CubeSats, or to small satellites more broadly;***

b) ***sets out exactly how the Government's plans for a 'traffic light' approach will simplify regulation for small satellites, and make it more proportionate; and***

c) ***outlines what work it is conducting to understand, and address, the debris risk posed by satellites, including satellite constellations and small satellites.***

85. ***To ensure that the pace of change does not slacken, the Government should commit now to a timetable for establishing regulations.***

Spectrum

86. The electromagnetic spectrum (or 'spectrum') is the range of all possible frequencies of electromagnetic radiation. In order to operate a network, a satellite operator must have access to spectrum for the Earth-to-satellite uplink and for the return path from the satellite to a ground station. The orbits that satellites occupy, and the electromagnetic spectrum they use to exchange data, are limited resources for which there is international competition. Access is managed by each country. In the UK, responsibility for managing civilian use of spectrum rests with Ofcom.

87. Since satellite networks have the potential to interfere with each other, their use of frequencies and orbital positions also needs to be carefully planned and coordinated at an international level. This process takes place within a framework of international rules operated by the International Telecommunication Union (ITU). Ofcom represents the UK in the ITU and acts as the notifying administration for the management of 'satellite filings'[130] for companies or other organisations registered in the UK, the British Overseas Territories, the Channel Islands and the Isle of Man.

88. Competing demands for spectrum, particularly between satellite applications and terrestrial mobile phone operators, were identified by Airbus, Inmarsat, ViaSat and others.[131] While there had been concerns that the space and satellite sector was 'losing out' to the mobile phone sector, and treated less favourably, a number of witnesses stressed that the relationship between Ofcom and the space sector was improving. Ob3 Limited, a UK satellite operator, highlighted the recently signed memorandum of understanding between the UK Space Agency and Ofcom which, it stated, was "an important step in ensuring effective support for the UK space industry".[132] Similarly, Stuart Martin from the Satellite Applications Catapult told us that Ofcom had been:

> leaning forward over the past year to try to understand the satellite sector better. I sit on the [space spectrum advisory committee], which is the one between the space community and Ofcom, and we have seen that engagement improve way beyond what I have known it to be in the past.[133]

130 'Satellite filings' refers to the process for obtaining internationally recognised orbital positions and frequency assignments for satellites.
131 Inmarsat (SAT0037) para 30; Airbus Group UK (SAT0016); ViaSat (SAT0009) para 4.1
132 O3b Limited (SAT0025)
133 Q37

89. Despite this progress, an ongoing point of contention related to a consultation launched by Ofcom in April 2015 on proposed changes to its procedures for the management of satellite filings. Joanne Wheeler, a lawyer specialising in space and satellites, told us that Ofcom's proposed changes would:

> put quite onerous responsibilities on satellite operators—new additional milestones, which are quite cumbersome, beyond what is necessary at [International Telecommunication Union] level and beyond what is necessary to other administrations from the ITU.[134]

She added that what Ofcom was proposing was "potentially more cumbersome than, say, what the French, the Dutch and the Germans are proposing".[135] In its response to Ofcom's consultation, Inmarsat concluded that:

> the addition of several of the new milestones […] would appear to over-complicate a process which has been working well to date, and which we believe already adequately covers the required information needed by Ofcom in order to enable it to fulfil its obligations with respect to UK satellite filings through the ITU.[136]

90. Philip Marnick from Ofcom, however, was adamant that its proposals were not "taking a tougher line than others", and that Ofcom was "trying to make sure" it could "give fair access to the people who need it".[137] Results from Ofcom's consultation were published on 30 March 2016, after we concluded taking oral evidence. In the case of the additional 'milestones' proposed, Ofcom stated that it took respondents' concerns "very seriously" and would "only request deliverables that will be already and easily available to applicants pursuing a real satellite project". Ofcom has also revised the text on the new milestones "to clarify what information [is required] and why".[138]

91. **We were reassured to hear that the relationship, and lines of communication, between Ofcom and the space and satellite sector are improving. We encourage the sector and the regulator to continue to work together to ensure that access to spectrum does not hinder the growth of the space and satellite sector.**

134 Q51
135 Q52
136 Inmarsat response to Ofcom Consultation: Changes to the Procedures for Management of Satellite Filings, 2015
137 Q205
138 Ofcom, Procedures for the management of satellite filings. A statement on amendments to the Procedures, March 2016

4 Looking to the future

92. We conclude this report by examining how the UK's space and satellite policy could be further refined in the future, with a consideration of the UK's relationship with the European Space Agency and the National Space Policy.

A national space programme?

93. As part of this inquiry, we considered whether the UK was striking the right balance between national and European/ international space endeavour. Witnesses broadly agreed that participating in the European Space Agency (ESA) enabled the UK to take part in valuable missions that it could not perform on its own. But this was matched by a concern that the UK space sector, and its ability to contribute to ESA missions, was being harmed by the lack of a national programme—something that other leading European space nations, including France, Germany and Italy have each established and continue to develop.

94. Many witnesses believed that, through developing a 'home-grown' programme, British national industries would be provided with a competitive advantage when bidding for European or global contracts. According to STFC, "other nations with large national programmes [were] particularly successful at using their nationally developed capability to underpin international programmes and thereby gain access to the missions their communities need". It warned that, without a national programme to generate technical and scientific advances, "the UK will increasingly have less to contribute to European programmes, and consequently increasingly lose influence over these programmes' directions and content".[139]

95. Witnesses from both industry and academia stressed the importance of national technology demonstration programmes, as discussed in paragraphs 57–60, and also suggested that a national space programme would provide leverage to participate in bilateral missions. The Mullard Space Science Laboratory noted that bilateral mission involvement "can enhance the relationship with countries in a way that other industries don't" and that they "tend to be faster and less demanding than [European Space Agency] projects, allowing for greater innovation, training and flight demonstration".[140] According to the Universities of Leicester and Oxford, however, the UK Space Agency does not currently have a mechanism for participation in, or funding of, bilateral projects with other space agencies.[141]

96. A solution proposed by some witnesses was to establish a modest national programme alongside the UK's contribution to ESA. Dr Marcell Tessenyi described how "our major European competitors (Germany, France, Italy) all do this and watch in amazement as the UK simply hands increasing amounts of money to ESA rather than running its own programme in parallel".[142] UKspace emphasised that a national programme needed "to be flexible in execution, enabling bilateral and multilateral partnerships".[143]

139 Science and Technology Facilities Council (STFC) (SAT0012)
140 Mullard Space Science Laboratory (SAT0034)
141 University of Leicester (SAT0003); University of Oxford (SAT0010)
142 Dr Marcell Tessenyi (SAT0018)
143 UKspace and techUK (SAT0020)

97. When we asked the Minister if the Government had considered the pros and cons of having our own national space programme, he replied that it was "an important bit of analysis".[144] His response, however, focused solely on how ESA benefits the UK and made no comment on the benefits or risks associated with establishing a national programme, alongside our contribution to ESA. Dr David Parker from the UK Space Agency later emphasised that the UK does have a "national space technology programme" that supports the development of technologies at low levels of market readiness.[145] Innovate UK welcomed the programme, noting that the "foundations" of a national investment programme were now "in place". It added, however, that a "good balance in terms of comprehensive national support programme has not yet been reached".[146]

98. **Over three-quarters of the UK Space Agency's expenditure is channelled through the European Space Agency which gives the UK a high return. An even greater return could be secured, however, through establishing a strong national space programme that builds on the foundations of the National Space Technology Programme.**

99. ***To place the UK space sector on a stronger footing globally we recommend that the UK Space Agency pursues an expanded national space programme, alongside its contribution to the European Space Agency.***

UK space policy

100. As far back as the 1960s and 1970s, House of Commons committees have complained that the Government of the day had displayed an absence of clarity, vision and purpose in its approach to the space age. In 1967, the House of Commons Estimates Committee described British space activities as "a story of wasted opportunities […] There has been no real space policy and no space programme as such".[147] Similarly, one of our predecessor Science and Technology Committees concluded in 1971 that the UK lacked "a coherent overall space programme", and had instead adopted a "piecemeal approach" which had tended to "lead to gaps and the neglect of important new projects".[148]

101. After a long spell without clear direction for the sector, several space strategies were published during 2010–15 Parliament. These included *A UK Space Innovation and Growth Strategy 2010 to 2030*, published in 2010 and updated in late 2013 by the *Space Innovation and Growth Strategy 2014–2030: Space Growth Action Plan*.[149] Both were produced by a team drawn from industry, the UK Space Agency, the Satellite Applications Catapult, Innovate UK, the Knowledge Transfer Network and academia.

102. Following the establishment of the UK Space Agency in 2011, a *Civil Space Strategy 2012–16* was published by the Agency, along with sector-specific strategies, such as the *Strategy for Earth Observation from Space 2013–16*.[150] Aside from the civil uses of space, a separate Government policy on *National Space Security* was published in 2014, setting

144 Q171
145 Q194
146 Innovate UK (SAT0038) para 28
147 Estimates Committee, Thirteenth Report of Session 1966–67, *Space research and development*, 27 July 1967, para 91
148 Science and Technology Committee, Fifth Report of Session 1970–71, *United Kingdom Space Activities*, 27 October 1971, para 22
149 Space IGS, A UK Space Innovation and Growth Strategy 2010 to 2030, February 2010; Space IGS, Space Innovation and Growth Strategy 2014–2030, Space Growth Action Plan, November 2013
150 UK Space Agency, Civil Space Strategy 2012–2016, 2012; UK Space Agency, Strategy for Earth Observation from Space 2013–16

out measures to make "the United Kingdom more resilient to the risk of disruption to space services and capabilities" as well as outlining ways to enhance UK "national security interests through space".[151]

103. The large number of strategies risked producing a fragmented approach to growing the sector. Stakeholders were generally persuaded, however, that the strategies had helped improve cooperation between Government, industry and academia. According to Stuart Martin from the Satellite Applications Catapult, the strategies have "been very much a framework within which the whole sector can move forward in a co-ordinated and managed way".[152]

104. During the current Parliament, the Government published its first ever *National Space Policy*. The Minister described it as the "first attempt to put in one place the totality of our Government's policy towards space", adding that it represented "a significant step forward in trying to consolidate, unify and reconcile different documents that have come up over time, all of which had a bearing on Government policy towards space".[153] Though witnesses did not question the need for such a document, concerns were raised about the lack of detail in the *National Space Policy*.

105. Innovate UK noted that the:

> most successful countries in building and exploiting space hardware can be characterised as having a clear vision for which capabilities, technologies and missions are important to them. They can then adopt strong focused positions.[154]

They believed that the "UK could learn from this".[155] In contrast, *the National Space Policy* was described by Professor Martin Barstow as "much more top level, very much headline stuff".[156] A similar point was raised by Ross Marshall from Clyde Space who, while supporting the growth target set out in the *National Space Policy* and earlier strategies, was still "looking for clear actions […] What exactly are we going to do about it? It is all quite high level at the moment".[157] When pressed on the level of detail included in the *National Space Policy*, Dr Parker described it as a "capping document […] which sits on top of the civil space strategy, the innovation and growth strategy and space security" and emphasised that "the policy is a policy; it is not a set of actions".[158]

106. There were also conflicting views about whether the UK's space strategies and policies were striking the right balance between focusing on commercial growth and investing in basic research to advance the frontiers of knowledge; an issue underpinning the space research funding gap examined in Chapter 3. In July 2015, the incoming Director General of the European Space Agency, Professor Johann-Dietrich Wörner, told the journal *Nature* that the UK Government was focused on getting a direct return from its investment,

151 HM Government, National Space Security Policy, April 2014
152 Q2; see also Q74–75
153 Q164
154 Innovate UK (SAT0038)
155 Innovate UK (SAT0038) para 40
156 Q74
157 Q120
158 Q165–167

rather than on fundamental research and the "full chain of innovation". He argued that there were "very smart scientists in the UK, and you have very good industrial partners […] One should not focus on only one or the other."[159]

107. When we asked Andy Green from UKspace about Professor Wörner's comments, he replied that he was:

> very proud he said that—really proud—because for some time the UK space industry and Government have been very smart about the way they operated with the European Space Agency […] Science and innovation are absolutely crucial, but we are right to try to focus that in the areas where we believe economic growth and jobs will come from.[160]

108. Dr Parker from the UK Space Agency told us that the Space Agency was "very consciously […] joining up the full spectrum from basic science and innovation through to technology development and applications".[161] Professor Barstow, however, considered that there was not currently enough "pull-through" from research into commerce, adding that it was "partly because we have not been pushing that button for long enough to see the real results".[162]

109. **The UK space sector has historically suffered from a lack of strategic direction and purpose. The UK's first National Space Policy, setting out the Government's high-level objectives for the sector, has been over half a century in the making. Its publication last year represented an important milestone but it is regrettable that it failed to include a clear, detailed vision of the capabilities, missions, and technologies the UK should be advancing. This was a missed opportunity which should not be repeated in the UK Space Agency's forthcoming Civil Space Strategy.**

110. ***We recommend that the forthcoming Civil Space Strategy sets out how the Government's four, high-level objectives, outlined in the National Space Policy, will be delivered. We also expect the Strategy to address the problems we have identified in this report that could prevent the UK's space and satellite sector from reaching its ambitious growth targets.***

Conclusion

111. Almost 50 years ago, a House of Commons Committee described Britain's space activities as a story of "wasted opportunities brought about by lack of purpose and the absence of any coherent organisation".[163] Without anything that resembled a coherent national space policy, or a national space programme, Britain muddled its way through the space age, and at times was relegated to the sidelines as other countries leapfrogged ahead. In more recent years, the industry, together with Government and academia, has endeavoured to start a new chapter in the UK's space story. Building on its internationally-

159 Elizabeth Gibney "UK shifts its space-science strategy", *Nature* vol 523 (2015) p 394
160 Q15
161 Q16
162 Q97
163 Science and Technology Committee, Fifth Report of Session 1970–71, *United Kingdom Space Activities*, 27 October 1971, para 22

excellent space science research base, and its industrial expertise, particularly in satellites and aerospace, the sector has delivered impressive economic growth figures, outstripping the economy as a whole.

112. With a National Space Policy and Innovation and Growth Strategies now in place, the UK is poised for further success. To reach its full potential, and increase the UK's share of the global space market from 6.5% to 10% by 2030, significant growth in the downstream, space-enabled services market is required. Overall awareness of the space and satellite sector, however, and its ability to address some of the 'Grand Challenges' that society faces, is worryingly low. The sector must become much more outward-looking and increase its engagement with organisations that could benefit from applying space-enabled services to meet their business needs. By capitalising on the downstream market, while continuing to invest in upstream innovations in satellites, the UK will cement its place as a leading space-nation.

Appendix

On Tuesday 1 March 2016, at Royal Society of Biology's annual 'Voice of the Future' event, hosted by the Science and Technology Committee in Parliament, we received a video message from Major Tim Peake, from on board the International Space Station. Below is an unofficial transcript of that message.

> Hello to everybody who's taking part in today's Voice of the Future event and welcome on board the International Space Station which is of course the world's largest research project ever undertaken through international collaboration. Firstly I'm very sorry I can't join you in person today but I have been handed a couple of questions from the panel which I believe I can address.
>
> Nicola Blackwood, Chair of the Parliamentary Science and Technology Committee has asked about the impact of my mission on the wider UK space sector. Well firstly, I'm extremely proud to be part of the UK's vibrant space sector which is based on 50 years of experience and today delivers excellence in satellite manufacturing, communications, robotic technology, instrumentation and services. Now, in order to continue this success, we need to create opportunities for growth and to inspire our younger generation to gain the skills that they need for the exciting careers that await them in the space sector. The UK's participation in ESA's human spaceflight programme has already created new opportunities for UK industry and there's an exciting future ahead. I believe that in the not too distant future, human spaceflight will become as routine as commercial aviation is today and the UK is well placed to play a major role in developing the capabilities that are needed to achieve this. I hope that my mission will help to show people that it's not just me who depends on space technology to live and work but it's all of us. And more and more of it is UK space technology thanks to the work of our industry and the UK Space Agency.
>
> Minister for Universities and Science, Jo Johnson, has asked about the life sciences experiments that I'm doing whilst on board. Now many of these focus on understanding more about the body's aging process and finding ways to counter the negative effects of growing old. For example, last week I conducted several ultra sounds which were to investigate increased stiffness of my arteries due to accelerated aging caused by microgravity. In addition to this, I was investigating changes to my vision and my immune system. And next week I will be involved in an exciting and complex European experiment called 'airway monitoring' which is investigating changes to our levels of airway inflammation and this research may also have a direct benefit for asthma suffers back on planet Earth.
>
> As an ambassador for microgravity research in the UK, I've seen how universities around the country are starting to take advantage of the unique environment that the International Space Station offers. I can clearly see that the UK is committed to helping to lead Europe through collaborative research and technology development through the European Space Agency. Our contributions to ESA make a real difference to British Industry and to universities but there's a great deal more that we can do.

I strongly believe that the future of scientific exploration lies in space. My time here on the ISS is paving the way for future missions beyond earth's orbit, a return to the moon and eventually on to Mars, whilst at the same time conducting research that will benefit humans on planet Earth and also helps us to better understand how fragile our planet is and how it works so that we can take good care of it. Now those missions are probably not for me but instead for those who are studying science and technology today. For example, students at Queens Park Community School or at Wallington High School who are participating at your event today. Of course, as well as the thousands of students that we've reached out to as part of our Principia campaign throughout schools around the country. So its been a real pleasure joining you today from 400km above the Earth's surface and my thanks to the Royal Society of Biology for organising the event. And so from the International Space Station I wish you a successful and enjoyable debate and goodbye.

Conclusions and recommendations

Innovation and growth

1. Government and local authorities could use space-enabled services far more to help them to achieve effective and efficient policy delivery. Slow progress in this area, however, has been compounded by the inward-looking approach taken by the space and satellite sector, which has failed to engage with a broad range of stakeholders. The Space for Smarter Government Programme (SSGP) provides a means to remedy this situation. It has successfully worked in partnership with Defra to ensure that the full potential of satellite data will be playing its part in helping the Department to deliver its policy objectives. Other Government departments, however, are trailing behind. The modest resources currently attached to the SSGP do not match the clear emphasis placed by the Space Innovation and Growth Strategy, the UK Space Agency, and the Government, on growing the space-enabled services market. The lack of a cross-Government roadmap for space services also presents a significant barrier to future progress. (Paragraph 25)

2. We recommend that the remit of the Space for Smarter Government Programme is broadened so that it is able to work, in conjunction with Government departments, to establish a cross-Government roadmap for using satellite data and developing space services. The roadmap should identify areas where the application of such services could help the Government deliver its policy objectives more effectively and where it would benefit from aggregating demand to reduce costs. This expanded remit must be supported by adequate resources. (Paragraph 26)

3. Through its promotion of the establishment of a UK Spaceport by 2018, the Government has placed the UK in a prime position to take advantage of the next leap forward in space technology—the development of re-usable, commercial spaceplanes. The focus on a horizontal-only launch capacity, however, may be too narrow and risk limiting the use and value of a UK spaceport to the industry. (Paragraph 35)

4. Before publishing its final 'technical requirements' for a UK spaceport, we recommend that the Government sets out the rationale, with supporting evidence, for limiting the scope of the proposed spaceport to accommodating only the horizontal launch of suborbital flights. The Government should also explain how it is ensuring that the spaceport plans will be further refined to meet the needs of UK space and satellite businesses, and what it will do to ensure that the proposal attracts the necessary private investment. (Paragraph 36)

5. Major Tim Peake, the UK Space Agency, the European Space Agency, and countless others have, together, inspired a nation through their excellent educational outreach and public engagement work around the Principia mission. It is vital that this enthusiasm for space is harnessed and is used to foster an enduring public interest in the UK's space sector, and the opportunities it holds. (Paragraph 40)

6. We ask the Government to outline its plans to ensure that the legacy of the Principia mission continues to raise public awareness of the UK's leading role in the global space sector, while also inspiring the next generation of scientists and engineers, long after Major Peake returns to Earth. (Paragraph 41)

Barriers to further growth

7. We were clear in our reports on Big Data and, most recently, Digital Skills, that the UK is facing a digital skills crisis. This crisis is already apparent in the space and satellite sector, where the need to process and analyse large amounts of data from satellites, and transform them into valuable insights, is a pivotal component of the Space Innovation and Growth Strategy. Without urgent action, data skills shortages could undermine, and potentially stall, the industry's progress towards its ambitious 2030 growth target. Existing initiatives, and the inspirational value of the Principia mission, are insufficient to tackle the magnitude of the problem. (Paragraph 48)

8. The Government should, as we recommended in our recent Digital skills crisis report, commit to addressing this crisis through a Digital Strategy published without further delay. (Paragraph 49)

9. The Government, Innovate UK, the Satellite Applications Catapult and the British Business Bank have, by working with industry, helped to create opportunities for companies with a high growth potential to access much needed capital. While there is scope to improve access further, the establishment of the UK's first dedicated investment fund for space is an encouraging and important step in the right direction. (Paragraph 53)

10. In response to our report, the Government should provide details of its progress on developing an export promotion plan for space. This should include information on export finance initiatives that will assist the space sector and how these compare with our international space and satellite competitors. (Paragraph 56)

11. A lack of flight heritage is a significant barrier that space and satellite SME's must surmount if their products are to become a commercial success. (Paragraph 60)

12. Given the scale of this barrier, we recommend that additional resources are made available to Innovate UK, so that it is able to expand further its In-Orbit Demonstration programme. (Paragraph 60)

13. Timely access to finance is vital if innovative UK companies are to reach their growth potential and break into the global space and satellite market. We are disappointed, therefore, to hear that the £60 million investment in Reaction Engines and its SABRE rocket, announced by the Government in July 2013, had not reached the company by February 2016. Delays of this nature risk blunting the competitive edge of nascent players in the sector by increasing the financial uncertainty that they face. We were particularly concerned to learn that material changes were made by BIS to the conditions of the grant without giving prior warning or explanation to Reaction Engines. (Paragraph 65)

14. Direct Government investment is an important element of space and satellite funding and should be conducted to the highest professional standards. The Government, however, appears to have fallen short of these standards in its dealings with Reaction Engines. (Paragraph 66)

15. *We therefore ask the Government to explain, in response to this report:*

    a) *why it changed the conditions of the grant made to Reaction Engines almost two years after announcing the investment;*

    b) *why it estimated that the first £35 million would be made available in 2014/15 and did not foresee any delays that EU State Aid regulations might present;*

    c) *whether any other space and satellite SMEs have been affected by similar delays in direct Government investment reaching them; and*

    d) *the key lessons it has learnt from this project and what changes it will make to the conduct of any future direct investments in the UK space sector.* (Paragraph 66)

16. Basic research is integral to building a successful space economy. The vibrancy and success of the UK space sector has resulted in more excellent research projects requiring funding than there are funds available. There is, however, a more deep-seated, systemic problem; namely that, under the current research funding structures, some satellite and space-related research proposals fall between the remits of the different Research Councils, creating "orphaned areas" of space research. Projects should not miss out on research funding because of inflexible administrative boundaries. (Paragraph 73)

17. We are encouraged by Sir Paul Nurse's focus on establishing funding mechanisms to deal with cross-cutting issues in his review of the UK Research Councils. The Government must explain how the newly-established UK Research and Innovation, overseeing the UK Research Councils, Innovate UK and HEFCE research funding, will be structured to avoid perpetuating the damaging, cross-cutting funding gaps. We further recommend that representatives from the UK Space Agency are members of the Strategic Advisory Boards of the STFC and EPSRC, to help ensure a more comprehensive, joined up approach to delivering research funding for space and satellite science. (Paragraph 74)

18. The current licencing and regulatory regime has not kept pace with innovations in the space sector. While we welcome the changes made under the Deregulation Act 2015, the regulatory status quo risks stymieing a key growth area for the UK space sector, namely small satellites and constellations. The UK Space Agency (UKSA) is beginning to address industry's concerns. Progress has been slow, however, and focused on the specific case of Cubesats, rather than small satellites more generally. It is vital that, while the UKSA maintains its reputation as a responsible regulator, it also does not adversely impede innovation and growth in the sector. We are concerned that the UKSA's draft regulatory proposals, as they currently stand, risk complicating the process when the intention is to simplify regulation and make it more proportionate. (Paragraph 83)

19. *We recommend that the Government, in response to this report;*

    a) *clarifies whether its published draft regulations are intended to apply only to CubeSats, or to small satellites more broadly;*

    b) *sets out exactly how the Government's plans for a 'traffic light' approach will simplify regulation for small satellites, and make it more proportionate; and*

    c) *outlines what work it is conducting to understand, and address, the debris risk posed by satellites, including satellite constellations and small satellites. (Paragraph 84)*

20. To ensure that the pace of change does not slacken, the Government should commit now to a timetable for establishing regulations. (Paragraph 85)

21. We were reassured to hear that the relationship, and lines of communication, between Ofcom and the space and satellite sector are improving. We encourage the sector and the regulator to continue to work together to ensure that access to spectrum does not hinder the growth of the space and satellite sector. (Paragraph 91)

Looking to the future

22. Over three-quarters of the UK Space Agency's expenditure is channelled through the European Space Agency which gives the UK a high return. An even greater return could be secured, however, through establishing a strong national space programme that builds on the foundations of the National Space Technology Programme. (Paragraph 98)

23. To place the UK space sector on a stronger footing globally we recommend that the UK Space Agency pursues an expanded national space programme, alongside its contribution to the European Space Agency. (Paragraph 99)

24. The UK space sector has historically suffered from a lack of strategic direction and purpose. The UK's first National Space Policy, setting out the Government's high-level objectives for the sector, has been over half a century in the making. Its publication last year represented an important milestone but it is regrettable that it failed to include a clear, detailed vision of the capabilities, missions, and technologies the UK should be advancing. This was a missed opportunity which should not be repeated in the UK Space Agency's forthcoming Civil Space Strategy. (Paragraph 109)

25. We recommend that the forthcoming Civil Space Strategy sets out how the Government's four, high-level objectives, outlined in the National Space Policy, will be delivered. We also expect the Strategy to address the problems we have identified in this report that could prevent the UK's space and satellite sector from reaching its ambitious growth targets. (Paragraph 110)

Formal Minutes

Tuesday 7 June 2016

Members present:

Nicola Blackwood, in the Chair

Victoria Borwick	Dr Tania Mathias
Stella Creasy	Carol Monaghan
Jim Dowd	Graham Stringer
Chris Green	Matt Warman

Draft Report (*Satellites and space*), proposed by the Chair, brought up and read.

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

Paragraphs 1 to 112 read and agreed to.

Summary and Appendix agreed to.

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

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

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

[Adjourned till Tuesday 14 June at 9.00 am

Witnesses

The following witnesses gave evidence. Transcripts can be viewed on the inquiry publications page of the Committee's website.

Tuesday 9 February 2016	*Question number*
Stuart Martin, Chief Executive Officer, Satellite Applications Catapult, **Andy Green**, President, UKspace, and **Dr David Parker**, Chief Executive, UK Space Agency	Q1–43
Joanne Wheeler, Partner, Bird & Bird, **Professor John Remedios**, Director, National Centre for Earth Observation, and **Dr Christopher Mutlow**, Director, STFC-RAL Space	Q44–73

Tuesday 23 February 2016	
Richard Peckham, Business Development Director, Airbus Group, **Professor Martin Barstow**, President, Royal Astronomical Society, and **Ruy Pinto**, Group Chief Operations Officer, Inmarsat	Q74–118
Patrick Wood, Group Managing Director, Surrey Satellite Technology Limited, **Ross Marshall**, Head of Operations, Clyde Space, and **Mark Thomas**, Managing Director, Reaction Engines	Q119–158

Tuesday 15 March 2016	
Joseph Johnson MP, Minister for Universities and Science, Department for Business, Innovation and Skills, and **Dr David Parker**, Chief Executive, UK Space Agency	Q159–196
Professor Ian Boyd, Chief Scientific Adviser, Department for Environment, Food and Rural Affairs, **Philip Marnick**, Group Director (Spectrum), Ofcom, and **Neil Ackroyd**, Chief Operating Officer, Ordnance Survey	Q197–219

Published written evidence

The following written evidence was received and can be viewed on the inquiry publications page of the Committee's website.

SAT numbers are generated by the evidence processing system and so may not be complete.

1 ADS Group (SAT0031)
2 Airbus Group UK (SAT0016)
3 Avanti Communications (SAT0026)
4 Bristol Spaceplanes Limited (SAT0049)
5 British Antarctic Survey (SAT0006)
6 British Standards Institution (SAT0039)
7 Caithness Chamber of Commerce (SAT0015)
8 CPOM/COMET (SAT0021)
9 Discover Space UK Ltd (SAT0005)
10 Dr Chris Lavers (SAT0001)
11 Dr Marcell Tessenyi (SAT0018)
12 Europlanet (SAT0023)
13 Goonhilly Earth Station Ltd (SAT0019)
14 Inmarsat (SAT0037)
15 Innovate UK (SAT0038, SAT0047)
16 Institute of Physics (SAT0043)
17 Institution of Mechanical Engineers (SAT0024)
18 Machinists Inc. (SAT0033)
19 Met Office (SAT0022)
20 Michael Johnson (SAT0007)
21 Michael Johnson (SAT0045)
22 Mullard Space Science Laboratory (UCL) (SAT0034)
23 National Centre for Earth Observation (SAT0017)
24 National Oceanography Centre (SAT0027)
25 National Physical Laboratory (SAT0040)
26 O3b Limited (SAT0025)
27 OneWeb (SAT0036)
28 Ordnance Survey (SAT0029)
29 Pupils 2 Parliament (SAT0008)
30 Reaction Engines Limited (SAT0046)
31 Rezatec Limited (SAT0002)
32 Royal Academy of Engineering (SAT0044)
33 Royal Aeronautical Society (SAT0028)

34 Royal Astronomical Society (SAT0014)
35 Satellite Applications Catapult (SAT0013)
36 STFC (SAT0012)
37 Surrey Satellite Technology Ltd (SAT0011)
38 Telespazio VEGA UK Ltd (SAT0030)
39 UK Space Agency (SAT0042)
40 UKspace and techUK (SAT0020)
41 University of Leicester (SAT0003)
42 University of Oxford (SAT0010)
43 Vaeros Ltd (SAT0004)
44 ViaSat (SAT0009)

List of Reports from the Committee during the current Parliament

All publications from the Committee are available on the publications page of the Committee's website.

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

Session 2016–17

First Report	EU regulation of the life sciences	HC 158
Second Report	Digital skills crisis	HC 270

Session 2015–16

First Report	The science budget	HC 340 (HC 729)
Second Report	Science in emergencies: UK lessons from Ebola	HC 469 (Cm 9236)
Third Report	Investigatory Powers Bill: technology issues	HC 573 (Cm 9219)
Fourth Report	The big data dilemma	HC 468 (HC 992)
First Special Report	Royal Botanic Gardens, Kew: Government Response to the Committee's Seventh Report of Session 2014–15	HC 454
Second Special Report	Current and future uses of biometric data and technologies: Government Response to the Committee's Sixth Report of Session 2014–15	HC 455
Third Special Report	Advanced genetic techniques for crop improvement: regulation, risk and precaution: Government Response to the Committee's Fifth Report of Session 2014–15	HC 519
Fourth Special Report	The science budget: Government Response to the Committee's First Report of Session 2015–16	HC 729