

Science and Technology Committee

Oral evidence: [Satellites and space](#), HC 804

Tuesday 9 February 2016

Ordered by the House of Commons to be published on 9 February 2016.

Written evidence from witnesses:

- [UKspace and techUK](#)
- [Satellite Applications Catapult](#)
- [Science and Technology Facilities Council](#)
- [National Centre for Earth Observation](#)

[Watch the meeting](#)

Members present: Nicola Blackwood (Chair); Victoria Borwick; Stella Creasy; Jim Dowd; Chris Green; Dr Tania Mathias; Carol Monaghan; Derek Thomas; Matt Warman; Valerie Vaz

Questions 1-73

Witnesses: **Stuart Martin**, Chief Executive Officer, Satellite Applications Catapult, **Andy Green**, President, UKspace, and **Dr David Parker**, Chief Executive, UK Space Agency, gave evidence.

Q1 Chair: I welcome the panel to the first session of our new inquiry into space and satellites with particular focus on innovation and growth in the UK. Like a good chair, I have been reading up on the various strategies and achievements in the UK. There have been some quite impressive achievements: a standard 9% growth between 2010 and 2014, and lots of infrastructure set up. I have been struck by the number of strategies flying around. I might miss out some of them when I go through this, but so far I have found: the space innovation and growth strategy 2010, with a space growth action plan update in 2014; a civil space strategy; a national space security policy; and a national space policy. We have also had quite a few bids for a national space strategy in our written evidence. I am trying to understand whether it is helpful to have so many strategies or whether it is undermining the direction and focus of public and private sector growth, in particular because I was very interested to read in the space growth action plan that the greatest challenge now is for the space industry to become more outward looking. Andy Green, perhaps you would like to start.

Andy Green: I will be brief. My name is Andy Green. I am president of UKspace. I am not heavily engaged in the space industry, but I was involved by the outgoing Labour Government—the last time they were in power—in running what was called in those days

an innovation and growth study. That was where the 2010 and 2014 reports came from. We tried to get industry, Government and academia in the same place as to what we ought to do, and I think that has been relatively successful. We set up the Space Agency and the Space Leadership Council and put in place an infrastructure that allows for communication and co-ordinated action.

In the way I think about these things I am not personally a huge interventionist, but in the space industry I have become completely convinced that because of its defence and political implications in the wider world it is possible for the UK space industry to prosper only when you have alignment between Government, industry and academia. What we have done is put in place an infrastructure that means that all those rather confusing titles do not confuse much on the ground. The difficulty with space is the outward-looking point—the last point you made. For us to continue to punch above our weight in terms of the jobs we create and the amount of the economy driven by the space industry, we need to apply space in day-to-day activities. Some of those strategies are about how Government can help with that and, for example, look across Earth observation and conclude what all the different Departments of Government want from it. Does it give us an opportunity to promote economic growth by thinking about the way that is procured, specified and driven forward? Some of it is about industry getting out there and driving more engagement with sectors like the transport industry and other areas where we believe satellite applications are very important. Innovate UK set up the Satellite Applications Catapult, which Stuart runs, and which is particularly important in that. In the interests of brevity, I will leave it at that, but the thing you will always hear me talking to everybody about is outward focus. We need to be talking not just about satellites, but to all the other sectors and Government Departments about what satellites can do to deliver departmental objectives, economic growth and better businesses for those sectors.

Q2 Chair: Perhaps I could turn to you, Mr Martin. In my experience, there are two kinds of strategy documents: there is the kind used to occupy lots of people that ends up sitting on a shelf and never achieves anything, and there is the kind that actually capitalises activity and stimulates progress. In your evidence, you echoed what Mr Green said about the need for the space industry to become more outward looking, and you said a key problem is lack of awareness of the potential for the space industry to generate productivity. Do you think that this activity, which is evident from the strategy, is stimulating growth and improvement, or is it occupying people when they could be doing something more effective?

Stuart Martin: You are absolutely right; there are two types of strategy. When we set out in 2010, it was vital that in developing the space innovation and growth strategy we had a concrete set of actions at the end of it with ownership identified, and a coherent force behind it driving everybody towards the goals of the strategy. That is very much what Andy has been leading over the five years since then, with industry and Government players and actors from the research community. That is one of the reasons why it has been so successful. Part of that has been to create things like the catapult, the Space Agency and a number of the other bodies that have led to some of the strategy documents you talked about. It has been very much a framework within which the whole sector can move forward in a co-ordinated and managed way to achieve the sorts of things you have been talking about.

In some of the things we are doing in the catapult, we are looking at how we help the sector turn itself to look outwards. What we identified in that strategy was the opportunity in the 2030 timeframe—all the objectives are set in that timeframe—to use space technology to deliver benefits to everybody on the ground, not “just” the objectives of what has traditionally been the space sector, without in any way intending to demean those, but, in addition, to look at how we can use space technologies to support the objectives of DEFRA, the transport sector, mining and retail—major components of the economy that we all recognise can benefit from better application of space technology. That is a very large part of what the innovation and growth strategy was all about, and certainly what the catapult was set up to deliver.

Q3 Chair: Looking through it, there are some very clear action points, some of them for delivery by your agency, Dr Parker. One in particular struck me because of evidence from the Satellite Applications Catapult. It was about the simplification of licensing procedures. There have been quite a few recommendations for the reduction of regulation and how it would improve UK competitiveness. In particular, it appears that, “Even the larger companies, with decades of experience of operating with UK licences, find the process unnecessarily complex and difficult to navigate, and it is even more of an issue for potential inward investors.” I see that action 2.5 of the strategy is that the UK Space Agency should simplify its licensing procedures wherever practicable. What progress has been made on that particular point?

Dr Parker: Perhaps I should say that there are a number of issues around regulation and sometimes they get mixed up. If I may first disassemble them a little bit, there is a licensing function for which the UK Space Agency is responsible, and that is related to meeting the Government’s responsibilities under the outer space treaties. It is about defraying or managing the unlimited liability that rests upon Government for any third-party damage caused by UK-registered objects. There is a second element associated with access to frequency, which is co-ordinated through Ofcom and represented internationally. There are other subsidiary aspects.

To take the first, the main one that we are responsible for, a lot of progress has been made in improving the licensing regime over the past few years: first, by bringing the UK into line with other countries—for example, France—in reducing the required insurance that companies are asked to provide to manage the risk. There is an unlimited risk on Government. We now ask the companies to take insurance of €60 million; it used to be £100 million. Secondly, we have removed the insurance premium tax that used to be paid in this domain. Thirdly, we have simplified the advice provided on our website and, most importantly, invited companies to come and talk to us directly. It is evident that the licensing regime is quite positively regarded by international organisations, because the number of licences we are providing has dramatically increased from four to six a year to up to 20 a year, so between a fifth and a sixth of all satellites are now being licensed through the UK. We have received very positive feedback from inward-investor companies comparing their experience with the United States and with other licensing regimes.

That is not, however, to be complacent. We have started the next round of work, which we set out in our corporate plan for the year, to look at how to manage the new types of satellites coming online. Traditionally, we have licensed individual satellites; now, groups

of satellites are coming through together. We have a study with the Aon insurance people to look at how we can aggregate insurance and make it more attractive and affordable; to make sure we are covering the full economic cost of licensing effectively; and how to manage increasingly smaller satellites, so-called CubeSats. The change that was made now allows us to assign a lower insurance requirement where we assess the risk to be manageable and sufficiently low. Usually, most satellite launches provide €60 million of insurance as part of the package anyway.

Q4 Chair: I suspect that colleagues will want to try to unpick some of those details and understand further some of the regulatory improvements that could be made, because this seems to be a consistent feature in the evidence we received. Perhaps I could return to Mr Green before colleagues come in. The overall goal of these strategies, as I understand it, is to increase our share of the global space market to 10% by 2030, which is about 100,000 new jobs, and achieve an interim goal of turnover of £19 billion by 2020, which is 8%. Do you think we are going to achieve it?

Andy Green: We have a good chance. I have been surprised by our ability to lock into the key things that are happening. The way we have made progress on small satellites, on the physical side, is very important, but on the services side an enormous amount depends upon the external lock-in that I talked about. We are making steady progress on 5G, for example, in making people think about the way a satellite can provide resilience and ubiquity. As all our devices—cars and those sorts of things—get even more embedded in the mobile networks, we need that resilience and ubiquity. I see very good signs. There are some difficulties. If all TV moves to the internet by 2030—not an impossibility—it will put a pretty interesting hole in the target. This is always fluid, isn't it? But I think progress has been good. We can point to strong economic outcomes from the money the Exchequer has spent and to strong growth for companies based here.

We have to match the openness of our regulatory environment with a very strong encouragement for people to bring jobs here. That is very difficult for the regulatory agency for lots of reasons, in terms of the way we think about the regime, but all of us need to be encouraging people to bring proper work here as part of what we are doing to stimulate the industry. It is an incredibly exciting time globally, if you look at what is happening in California and the way that is changing. One of the things we are going to talk to the Minister about today is how we can get a better UK share of the big constellations that the Californians are trying to put up at the moment. Why do we think that is important? Because it is where a lot of the funding is being directed, and we need to take advantage of our relationships with the US on many fronts to get those things done. There is a lot of work to do, but I am optimistic.

Q5 Matt Warman: You have touched on some of this already, but do you agree that it is still the case that small businesses and the public sector do not yet know enough about the benefits of the UK having a serious investment in space?

Andy Green: Absolutely, and I would not duck responsibility for it either. The point about the industry tending to get highly involved in insurance, launching and all the things it does, forgetting that the way to develop a vibrant and exciting sector is to engage people who are in completely different sectors, is critical to us. I am very excited by the start-ups.

In the six years I have been involved, I have seen a different atmosphere at Farnborough, both in the number of foreign companies interested in coming to talk about space but also the number of successful small companies like Clyde Space, and CubeSat and those sorts of things. These are great stories, but we have to find more of the companies that will help Network Rail keep their lines open by using satellites to notice when things are shifting in the world and all those sorts of things. We have to catch things that impact on the real world, and we have work to do. Stuart's team is doing a sterling job, but everybody in the industry needs to concentrate on that.

Stuart Martin: We spend a lot of our time with organisations, from local councils to supermarkets or anyone you can imagine, having conversations with them and helping them to understand what space technology can do. Every time it starts with, "Space? What on earth has that got to do with us? We are a supermarket or a local council," but once we have had that conversation they start 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. We have the same conversations with investors, because we are trying to attract them to the community. They have the same perception about space. One of the reasons we are called the Satellite Applications Catapult is that, if you talk about satellites, people do not immediately begin to bristle in the same way as they do about space. They start to understand that there is an economic side. We have learned a lot about how to have those conversations to make them productive, and a lot of collaborations have come from that. We are working with people like Sainsburys, Milton Keynes local council, Anglo American mining and Shell—large corporates and local organisations all trying to understand how they can make greater use of satellites to give them a competitive advantage.

Dr Parker: What the catapult is doing on that side is part of the bigger strategy of actions, which includes some of the programmes we do through the European Space Agency. For example, we have a series of small programmes that are developing opportunities and integrated applications in the commercial world where the satellite bit is all but invisible to the end user; it is about the service that is provided. The same thing applies to our space for smarter government programme, where we are focused on how the rest of Government takes up the use of space data. As Andy says, we are on the cusp of enormous change, where with Earth observation, 10 times as much data is starting to flow down through the Copernicus programme. Suddenly, this data is available and free, and it will be there for the long term, so people can start to build services on it rather than its being just a little demonstration that is quite interesting but then stops at the end. It is great to see DEFRA coming on board and being a positive champion, with the Secretary of State going out in public and saying, "We're going to put Earth observation at the centre of our policy delivery." We hope that will be a trail-blazer for other Departments. Our space for smarter government programme is deliberately setting out to build partnerships with other Government users to deliver their policies and services.

Q6 Matt Warman: With that in mind, where are the biggest gaps or opportunities—depending on how you put it—we have not yet got into?

Dr Parker: With Earth observation, we are just on the cusp with DEFRA because potentially it is an enormous user for all sorts of applications and services in its policy domain: for example, monitoring agricultural policy. We have a project with Leicester University looking at localised pollution monitoring, providing very localised data for local authorities; there are land use and maritime applications and so on. That is just Earth observation. Then you start to think about the navigation applications of Galileo that are coming on board—civil security, blue light services and landing aeroplanes in remote locations very safely. All of that is about to happen as well.

Q7 Matt Warman: You bring me to my next question. What sort of plan is there to promote the services that Galileo is going to make possible?

Dr Parker: First, we have to get the early services operational, which will be in the next year or so. The satellites are starting to go up a lot more regularly now, which is reassuring. Once the early services are there, we have invested particularly in technologies to exploit the so-called PRS signal. What's that? It is a signal that does not just tell you where you are; it has much more protection against jamming and spoofing, so it can be relied on for safety-of-life applications. It is akin to the military code that already exists in GPS but is now available to civil authorities. We have invested in the R and D that allows people to use that, and the promotion and uptake of it is a really exciting opportunity. People reckon it is a £7 billion opportunity.

Q8 Matt Warman: But in terms of practical promotion, it sounds like you are a little way off.

Dr Parker: We are at the stage of working with civil users, because the use of PRS is in the Government domain, not the public domain. We are talking to potential users of autonomous vehicles. I think Stuart is involved in some of the parallel R and D work going on.

Stuart Martin: Absolutely. We have just started a piece of work with the European Space Agency on developing a demonstration centre focusing on GNSS technology, with Galileo very much at the centre. We are looking at how to use the new capability—PRS and some of the other services Galileo offers that are not available from normal GPS—in order to do things like making UAVs more resilient, so they are less easy to take over and control by spoofing, and do not ultimately cause crashes. That sector can be supported, but, more broadly, how can the transport and maritime sectors take advantage of the new services Galileo will offer? That is something we will very much be driving forward at the catapult.

Q9 Matt Warman: You mentioned that Galileo satellites were going up more frequently. There were earlier reports about some of them being put into incorrect orbit and one of them having a power failure. Can you offer us a little reassurance that that is not going to be the main story we are hearing in a few years' time?

Dr Parker: I sincerely hope that is not going to be the case. Two satellites were fully functional but launched in a slightly incorrect orbit. They are being used for R and D purposes, unfortunately, but an order is about to be placed for the next batch of satellites,

so the production run is going well. The good news is that more than 20% of the value of Galileo is being built in the UK space sector. It has already been a major boon for the UK space sector in terms of R and D and growing industrial capability.

Q10 Matt Warman: We are confident that we know what went wrong.

Dr Parker: In that particular case, yes; that launch failure was well understood.

Q11 Carol Monaghan: I am listening with great interest to a lot of this. It is great to hear you are talking to councils and supermarkets like Sainsburys about the benefits of space and space technology. We regularly hear big stories about space—for example, Tim Peake, or about space disasters when things go wrong or about the space station passing over—but there is still lack of public awareness generally of what space does for us in our everyday lives. I visited Clyde Space last week. That is a company in Glasgow which now has to expand its premises because it has been so successful. People in Glasgow do not know about it. What steps do we need to take to ensure that the public are not just on side with space but that they see it as a viable career choice or opportunity for them?

Dr Parker: That is an excellent question. It is a bit of a conundrum. There are two sides to space: the exciting and inspirational aspects—astronauts and the space station—and the practical down-to-earth applications, and people very often do not link the two. The answer is to keep telling the positive story of what is going on. People are always surprised when they visit space companies and see satellites being manufactured. Clyde Space is an example of a company that grew out of some R and D we put with it three or four years ago to build its first satellite, and now it is selling them all round the world. There is also the practical thing; generally speaking, unless you go to a factory you never see space hardware. You see a car on a road or you see an aeroplane fly over. All the hardware or infrastructure is invisible in everyday life, but you would notice if it was turned off. You would notice if satellite TV disappeared or you did not get a decent weather forecast.

Part of what we are doing with the education programme around Tim Peake—we are spending about £3 million on that education programme—is not just about exciting astronauts going up there and doing exciting things; it is also about Earth observation. We are working with NERC to get kids to understand how space is being used to look at planet Earth and how it is changing. There are fitness challenges, to understand the health aspects of going into space, and the technologies that support that. There is also planetary exploration, which is always exciting. When you go out into the solar system, it opens a door to tell the wider story of what space is about, but ultimately the range of things happening is a story we have to keep telling over and over.

Q12 Carol Monaghan: The message is probably filtering through slowly, but maybe what we have to do is switch off signals from satellites for 24 hours and let people see the result.

Dr Parker: That has been suggested.

Andy Green: It would certainly work.

Dr Parker: It literally happened a few weeks ago. One GPS satellite had problems and stopped operating, and suddenly there were time signal problems back on the ground. We do not want that to happen—I put that on record—because the impact would be significant very quickly. Space has now been designated as critical national infrastructure. That tells you how important it is, because certain aspects of the space infrastructure are critical to the economy.

Q13 Carol Monaghan: That message has to get out.

Stuart Martin: Having been in the sector for all my working life, over the past 10 years it has dramatically improved. Now the level of understanding among the media, politicians and the general public, even though you are absolutely right that it is still at a relatively low level, is on the right path. We need to keep doing more. It is hard and we have to keep going at it, and initiatives such as this inquiry and the opportunities around Tim Peake give us a great platform from which to try to get out that message.

Q14 Valerie Vaz: We must not forget Helen Sharman, who was also an astronaut. We keep forgetting her completely.

Dr Parker: Of course.

Q15 Valerie Vaz: You mentioned the European Space Agency. Are you surprised to hear that the director general thinks the UK Government are focusing too much on the commercial side rather than basic research—what he called the “full chain of innovation”? Where do you see that balance? Is that fair or unfair?

Andy Green: I am allowed to be outspoken. I am 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. Having Tim Peake out there is a good thing. What it cost us compared with our compatriot countries was very small. We have concentrated on telecommunications, Earth observation and the things from which we believe economic benefit will come.

I am fired up by the jobs and economic growth that space can bring to the UK. That is why I do this. I do not do it because I get paid; I do it because I care passionately about that issue. 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. I know that blue sky is good too, and we are pretty good at that in this country. We have universities that do a lot of great blue-sky innovation. When it comes to the European Space Agency, for me the slightly applied science view we have taken on it has been smart and a good thing to do. I have a very clear view on that.

Q16 Valerie Vaz: You do not think there should be a focus on both—that you could have both. I do not think you have quite answered my question. I asked whether you thought it was a fair criticism. When you talk about commercial applications, it usually starts with blue-sky

research, doesn't it, and then you see the practical implications? Do you think that criticism is fair, Dr Parker?

Dr Parker: From the perspective of the Space Agency, we are very consciously about joining up the full spectrum from basic science and innovation through to technology development and applications. The role of the agency is to be a leader across the whole picture. The agency is not attempting to do all of it by itself. That is why we have different delivery organisations, but I believe the overall picture—I am happy to talk to Johann Wörner about it—is a very coherent picture of getting the balance right. You will see that our investment in the European Space Agency has gone up over the past four or five years. Where it has gone up is in some of the commercially oriented activities, primarily telecoms, but we have also started to invest in the life and physical sciences programme of ESA—the science that is happening on the space station. Yes, there has been quite a big increase in investment in telecoms, but there is also a little bit of new investment in fundamental science. The work of fundamental research that goes on in universities that feeds through into innovation is completely vital, and that coherent picture is one that we hold rather close to us.

Q17 Valerie Vaz: There is a little bit of innovation. He is trying to say that there should be more, or an equal balance.

Dr Parker: Science and innovation may be slightly different things, so we have to be careful about language. We are the third largest investor in the fundamental science programme of ESA, the fourth largest investor in life and physical sciences and the second largest investor in Earth observation sciences. We invest significant amounts in the science programmes. The place where we are not investing is the big launcher programme, but where we invest it is always to play to our national level of investment and strengths, and that includes science.

Stuart Martin: In our evidence we agreed that we need to fund and support the full range from fundamental science through to applications. Certainly, from where we sit on the business side of the interface, that research needs to be there for us to pull it through from the research community and exploit it. Today, in France, which is known as a big funder of space in Europe at pure research level, they are doing an inquiry pretty much like this one; it is a locally focused inquiry on the way they handle space. They have invited Johann Wörner from the European Space Agency and only one other country—us—to participate to help formulate their plans, because they see that what we are doing on commercial exploitation and pulling it through is a bit different from what anyone else is doing, and that is a real strength we have.

Q18 Valerie Vaz: You are now going to desert us and go off to see the Minister. When you plan your missions, are you putting a business case to him and the Government as a priority over anything else? Do you first have to make a business case?

Dr Parker: That is correct. Any new project, or set of programmes, is based on a business case that has to meet Treasury Green Book considerations, but the Space Agency at least is funded from the science ring fence, so that fully accepts the value of fundamental

science, as well as stepping into the innovation and applications world. Yes, new programmes are based on business cases.

Andy Green: It is not just a case from business. For example, even business is talking about spaceports. They are not things likely to affect the career of any of the businesspeople who sit around the table, but we believe they could potentially be very interesting over a long period of time for the UK economy. Of course, we are interested in making sure that the economics are sound, but it is not a case for business that is made at the Space Leadership Council; it is a much more balanced case than that.

Q19 Valerie Vaz: But you look at the impact on British industry, don't you, as the primary factor?

Dr Parker: It is one of the considerations, but it is also the impact on science, education, skills and even international policy, for example.

Q20 Valerie Vaz: I want to touch quickly on the funding part of it. You said you were part of the ring-fenced budget. Are you coming under UK Research? Will you be part of that? Sir Paul Nurse was confident that we would not be looking at just the commercial side but at blue-sky thinking, because that is really what scientists are about, aren't they? I want to know where you fit into that scheme.

Dr Parker: The agency is an Executive agency of the Department, so it is not an arm's length body in the same form as the research councils.

Q21 Valerie Vaz: You would not come under UK Research at all.

Dr Parker: I do not think any decisions have been made in that direction. I have not heard anything.

Stuart Martin: We receive our funding through Innovate UK, which is the UK's innovation agency. There is discussion about moving Innovate into Research UK, as you know. That is another discussion. On the role we and Innovate play on the business side, one of the reasons why we have been successful in innovation over the past five or 10 years and have risen in worldwide rankings on the innovation scale is that we have that mix of business-led innovation pulling through research from the science base. If we tinker around with how we govern all of that, we must be careful that we do not lose the nugget of value we created that is so well recognised around the world.

Q22 Chair: Mr Martin, to clarify one point in your written evidence, you say: "There is a gap around early-stage satellite specific engineering, ICT and communications development, because EPSRC does not support the space sector and STFC only funds space science." As you have just said, the Space Agency is not a research council and, therefore, cannot fund research. Is that still the case? Are there any plans as to how that gap is going to be plugged, or is Innovate UK addressing that at the moment?

Stuart Martin: I think there is still a gap. What I refer to there is that the industry at the moment is going through a period of quite rapid change, as we go from having fewer large satellites to a larger number of smaller satellites and constellations, as we have already talked about. The manufacturing and engineering processes need to be brought up to the level needed to produce those volumes of components or satellites. At the moment, if a small business in the space sector has an order for a satellite, it might be for one or two components, but in the future it will be asked for hundreds or thousands of components, and that is a very different proposition. The engineering and manufacturing processes need to be taken on a journey so that they can evolve to meet the new demand, and at the moment that is a problem.

Q23 Chair: Post the Nurse review and as the process goes through, any gaps like this should be considered and filled. Mr Green, where do you think it should sit?

Andy Green: We have said to the Nurse review that both universities and small businesses see this as an issue. We thought the proper way forward was to make a submission to the Nurse review to try to address it. We do not know the outcome.

Q24 Chair: Have you presented it as a problem or with a recommendation for a solution?

Andy Green: I am afraid I cannot recall. I do not think we could work out exactly how to fix it.

Q25 Chair: Where it should sit; okay. Dr Parker, did you have any suggestions?

Dr Parker: From the Space Agency side, we have certainly discussed the issue with EPSRC. Everybody is waiting to see the overall financial allocations, but beyond that I would be very happy. We have a national space technology programme, which is an industry-facing R and D programme, but if it made sense to ring-fence part of that to work alongside EPSRC in what we call astronautics research—basic university level research—we would certainly be open to that.

Q26 Chair: Mr Green, would you mind sending us the submission that you made to the Nurse review so that we can look at it alongside the inquiry? It would be very helpful.

Andy Green: Yes.

Q27 Derek Thomas: I ought to declare an interest, or possibly just thorough excitement. In my constituency, I have Goonhilly Satellite Earth Station but also RNAS Culdrose and nearby Newquay airport. It is a part of the world where we are particularly interested in this subject. Goonhilly tells me that a space-based service market is what it wants to get involved in and do more and more of. I am assuming that that requires affordable and reliable access to space. Mr Green, you touched briefly on a spaceport and what that might mean for the UK in future. Would a spaceport deliver that kind of access to space for small satellites and payloads? Is that something that could work with a spaceport?

Andy Green: We are now in the realms of trying to predict a difficult future, but with the continuing progress SpaceX has made recently with a successful landing—or an unsuccessful one—reusable vehicles will become part of the space industry within a reasonable period of time. There will be both rockets and planes. What Virgin Galactic is doing is potentially on the way to being able to launch satellites as well. Personally, I think it is the right moment to consider it and look at the regulatory, legal and economic framework that allows the UK to take part. It will have a significant economic impact over a longer period of time, but if you do not get on the road, you will not be part of that future. I am very positive about us taking concrete steps to do that. There are quite a lot of issues to resolve. Some people feel it is very urgent; others less so. That is one of the things we will talk to the Minister about later.

Q28 Derek Thomas: That takes me to my next point. Is there general agreement across the sector that there is a need for a spaceport in the UK?

Andy Green: No. You never get general agreement on these things. A large part of the sector is very positive about it; other parts worry that it will divert funding from things close to their heart, but one of the points about my being a little bit independent from all the major companies is that part of my job is to smooth some of those thoughts away. There is certainly significant interest from a lot of very innovative and interesting companies about the possibilities that a spaceport physically based in the UK can deliver.

Dr Parker: Perhaps I can first place it in the policy context, which is the whole issue of lowering the cost of access to space. We have fully reliable access to launch our large satellites into space. There are already two or three different places from which you can launch your big telecommunication satellites. That is not what we are talking about. We are not talking about replacing Ariane 5, or something like that. It is about building on what we started to do with the likes of Clyde Space, and before that Surrey Satellite, which is the UK strength in small spacecraft. The value of spacecraft is what you do with them, which is the applications—for the companies building and selling spacecraft to be able to offer an end-to-end service which is, “I’m not selling you a spacecraft; I’m selling you a spacecraft in orbit.” They are the ones saying to us that the opportunity to have independent access for putting small satellites into space could make good business sense. Again, it is about supporting the complete value chain. Where we are at, given that the UK has not been doing this for a very long time, there is a nascent market for suborbital space tourism that could provide a stepping stone. That is the logic of what we are doing at the moment.

Q29 Derek Thomas: To carry on that conversation, is the role of Government just to facilitate the spaceport or is it to fund it?

Dr Parker: The key role of Government is to provide the regulatory environment, because we are talking about very high, powerful vehicles travelling at great speed through civil airspace. That has been a critical role in building the relationship we have with the Civil Aviation Authority, to lead on how to regulate those vehicles flying through airspace and ensure there are no risks, or that there are acceptable risks, to the uninvolved general public. That is the first key role.

The second one is that the technology is extremely sensitive. You only have to consider the concerns over the weekend about North Korea's satellite launch to realise that this is dual-use technology, so there is a critical role for Government to mediate in any technology transfer issues. Central Government have always been very clear that it is not their role to build a spaceport, but what you need for a spaceport is not tremendously ambitious. Essentially, it is a very long runway, the facilities to handle the vehicle and the airspace in which to operate it.

Derek Thomas: I would suggest that Newquay is the ideal place for that.

Carol Monaghan: Or Tayside.

Q30 Derek Thomas: I am conscious that both Scotland and Wales feel the same. You mentioned the need for a long runway. At the moment there is no plan for vertical launch in the UK. Is that going to hinder our ability to keep up and continue to compete, or is the long runway good enough for what we need to achieve?

Dr Parker: It is clear that different organisations have different solutions. There are colleagues in Scotland who are interested in vertical launch, but our key role is to focus on the regulatory and safety aspects. Ultimately, it is a business choice.

Q31 Derek Thomas: Mr Martin, I appreciate you have not said anything. Do you want to say anything before I conclude my questions?

Stuart Martin: I support everything everyone else has said. The opportunity, and indeed the threat, identified in the 2010 IGS report was increasing uncertainty around the availability of launch because of depletion in the Russian ICBMs that had been used to provide low-cost launch in the past, and the increasingly difficult geopolitical environment that would provide access to those anyway. That uncertainty in availability was a barrier for the sector, because it was becoming more and more difficult to source launches for satellite projects. At the same time, there was a change in the sector related to smaller satellites and constellations. The market was changing, and it looked as though there was an opportunity for someone to come up with a new proposal for how we could launch small satellites and constellations. There was a threat and an opportunity. With our location and industry, we felt that was an opportunity the UK was well placed to take advantage of, and I certainly still do. There is a great opportunity for us.

Q32 Jim Dowd: Dr Parker, in your replies to the Chair's earlier questions you covered much of the ground I want to look at. You mentioned reduction of the liability to €60 million and the removal of IPT as being helpful, but the UK still demands full liability insurance, whereas most of the others in the field—I will not refer to them necessarily as competitors—require liability cover only for the launch. Is the burden on British operators an unfair one?

Dr Parker: I go back to why we are doing that. We are doing it because of the unlimited liability that rests on Government. In an environment where outer space is becoming more congested and contested, there is a balance between economic opportunity and being a

responsible user of the space environment. We take our responsibilities rather seriously from that point of view.

The change made to reduce the insurance level to €60 million also gives us flexibility to set the insurance level. That was the logic for the piece of work that our chief engineer did last year, which was to look at whether we could have a simplified red, green and amber pre-screening for satellite launches. If it is green, it is a low-risk mission and we can assure you about issuing a licence and we can look at the insurance levels, all the way up to some of the less serious—I was going to say less outlandish—proposals where people want to put satellites the size of playing cards into high orbit where they cannot be tracked. We are not going to license those kinds of high-risk activities. We are moving towards a more graduated insurance regime that is more flexible and has to respond to the world of more satellites and constellations of satellites, as Stuart was saying. It is not a one-size-fits-all solution. That is where we need to get to. I have discovered that the process of changing regulation through Government is a lot more complicated than rocket science.

Q33 Jim Dowd: Actually, it is rocket science. Perhaps you anticipate my next question. Rather than a single liability for all operations, should it vary? Should it vary according to size? You mentioned CubeSats. There are nano-satellites, going up to much larger ones like telecom satellites. Should it be according to size or according to the nature of the satellite?

Dr Parker: It is going to be more than just size. For example, a very small satellite deployed in low orbit, which is guaranteed to re-enter in a year, is really low risk, but you can have a very small satellite launched into high orbit. Some CubeSats have no means of control and, effectively, in operational terms they are space debris from the moment they are launched, so they carry risks because they have no ability to manoeuvre out of the way of something else. With Clyde Space's UKube-1 we were getting conjunction alerts fairly regularly—that there was a risk of its crashing into something else. It is more than just the size of the satellite. You can have a small satellite in a risky place and a small satellite in a very safe place. Other factors come into play.

Q34 Jim Dowd: Are you satisfied with the work you have done in evaluating the risk from congestion in space, and the ever-increasing amount of space debris up there?

Dr Parker: The answer is that more needs to be done. At the moment, the ability to track extends to something about the size of a tennis ball, or a 10-centimetre cube. We cannot track anything smaller than that at the moment, and there are plenty of things smaller than that. The space station is regularly moved out of the way of debris objects. We have to do more on the space surveillance and tracking side. We are doing that by working through the European Union. For some of the new constellations coming along—satellites that have hundreds of satellites—we are doing some mathematical modelling to understand the risks associated with them, and that feeds into the regulatory work.

Q35 Chris Green: Dr Parker, responsibility for civilian allocation of the electromagnetic spectrum rests with Ofcom. The innovation and growth strategy states that the UK needs “a strong champion at international regulatory meetings” to ensure that the UK gets its share of this scarce spectrum. Is Ofcom currently doing enough to be that champion?

Dr Parker: A lot of concerns were expressed by the space sector on this a year or two ago, but one of the things that the agency took action on, working to the Space Leadership Council, was to set up a joint working group between the agency and Ofcom, co-chaired by my policy director and the relevant person in Ofcom, to be able positively to engage with the space sector, particularly leading into the World Radiocommunication Conference, WRC-15, that took place last year. That is a way of saying the evidence is that things are much better, because Ofcom was starting to receive letters of thanks from satellite operators about how it represented and secured their interests, particularly around Ka-band—satellite broadband—at WRC-15. There is always more work to do, but the trend is positive.

Q36 Chris Green: From the outside, one would think about the money and strength of mobile phone operators, for example. There are other organisations that may have far more clout with Ofcom and might have more money backing them up. Are those concerns and problems being resolved at the moment?

Dr Parker: Ofcom was very direct. It said, “You have to come and tell us why you are important. You’re not going to be treated as a special case, but tell us what is your case.” Often the case is that it is not just the value of the satellite operators in the UK; it is that, because they are selling abroad, it is an export opportunity. They are supplying services globally, and that has a real economic value, which perhaps was not being appreciated beforehand.

Andy Green: The space industry has definitely been delighted by the way the whole strand of work between Ofcom and the Space Agency turned out. The reason Ofcom listened was that we were able to put together a clear single voice from the industry, which perhaps we did better than the mobile industry managed to do on this occasion. We are a relatively small but new and growing sector, and therefore it is very important that we speak clearly and with one voice.

Q37 Chris Green: The key thing is that with the space sector growing quite rapidly, and with its potential, so much is unknown about it that you have to be able to secure the spectrum in the future. That potential has to be there in the spectrum. Are you confident about unknowns developing?

Stuart Martin: There will never be enough spectrum. That is just one of life’s certainties. It is about how we all get better use of that spectrum—between all the different communities. I echo what David and Andy have already said. Ofcom has been leaning forward over the past year to try to understand the satellite sector better. I sit on the committee David mentioned, 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. Leading up to the congress in November last year, it was very professional and much appreciated.

Q38 Chris Green: Ofcom is in the process of a strategic review of satellite and space science spectrum. From the sound of it, you will be quite positive about the outcome of that. Is there anything that you particularly desire from that review?

Stuart Martin: Just to keep that work going forward and let it follow its conclusions. We are pleased by Ofcom's level of engagement and its willingness to try to understand the sector's current and future needs. It wants to understand how the sector is itself evolving, which is very much part of where our concerns are.

Q39 Chair: I know that you have to get away for your meeting, so we will not keep you too much longer. I have two final points of clarification. We have had evidence that expertise and procurement for satellites and space products across government is a bit fragmented and sometimes duplicated. I have evidence here that I think means the same thing but it uses slightly different and confusing words, so I want to check that I understand it properly. UK Space proposes that the Government play a role as an anchor tenant, and the Satellites Applications Catapult proposes a centralisation of procurement for satellite services and that the Government play the role of launch customer. I am assuming that "anchor tenant" and "launch customer" mean the same thing.

Stuart Martin: They can be the same thing.

Andy Green: This is the bit where we started. Government play a significant role, because space and satellites can support so many different departmental outcomes. We are beginning to see more and more Departments understand that, but the question is how we can bring together those needs in a way that enables procurement to take place so that we end up with more satellites providing more data that is helpful to those Departments. It may not be possible for an individual Department to generate enough demand to undertake one of those procurements. That is what we are getting at, and we are all working hard at it. I think we are both getting at the same thing.

Q40 Chair: Is there work ongoing to achieve that outcome?

Dr Parker: There is. I mentioned the space for smarter government programme, which may be a slogan, so to get behind it a little bit, the work that our team in the catapult and other colleagues are doing underneath the group set up by the DECC permanent secretary, Stephen Lovegrove, is to look at the potential for Earth observation across government, and what actions the Government need to take. We are awaiting the recommendations that come out of that work, but hopefully it is a kernel that will lead to a sustained approach.

The one note of caution, to some extent, to industry colleagues is that aggregating demand does not automatically lead to the need to build a spacecraft; in other words, we have the Copernicus system which is being put up and provides a huge amount of data. It is a whole fleet of satellites. A single spacecraft would spend 99% of its time not over the United Kingdom but would be looking somewhere else, so the business case is: how do you meet the demand? It might not be by building another spacecraft but by effectively using the data being made available already.

Q41 Chair: The last point is about skills, which we have not talked about at all. We are doing a digital skills inquiry and have just finished a big data inquiry. As a committee, we feel that digital and data skill shortages in the UK are approaching crisis levels. Mr Green, we

have had some evidence from you that there is serious concern in your industry as well. Would you mind fleshing that out?

Andy Green: I had better declare an interest. I am deputy chair of the Tech Partnership and chair of the Digital Catapult as well.

Chair: We had evidence from them.

Andy Green: Digital skills are a real crisis for the country. We need the same types of skills; we are able to do some of the industry-specific skills, but a lot of what we are talking about when referring to outward focus is the ability to analyse masses of data coming from Copernicus and other things, and making it work in the real world. The country needs more skills. There are big interventions around things like the apprenticeship levy, but I am very concerned about the split between DCMS and BIS in terms of digital now being a DCMS responsibility and BIS having all the funding around education and innovation. I worry that this is falling through the cracks and we will slow what is going on in digital skills, not accelerate it, but I did declare my interest.

Q42 Chair: If that happens, what will be the impact on achieving the goal of 8% by 2020 and 10% by 2030?

Andy Green: As with all these areas, it will make it harder and harder for small companies to start up and find the skills they need in the UK. Data can be processed anywhere, so the passion I have for seeing jobs and economic growth land in the UK will become much more difficult, because people will have to take businesses to where there are skills elsewhere in the world.

Q43 Chair: Does everyone agree?

Stuart Martin: Yes. I cannot add anything to that.

Dr Parker: The space sector cannot solve that problem by itself. What the space sector can contribute is the amazement and excitement of space, inspiring people at a young age and hopefully passing the parcel, as it were, to the next level of engagement in STEM as they go through the education process, but awareness of jobs and opportunities is something we have to do as well.

Chair: Thank you. I am afraid we have to move on to our second panel. Thank you very much for the evidence you have given today. We may well follow up with a few questions. We hope we will produce something that helps to raise awareness and inspiration and gets some of those people with the skills we need to grow and meet our goal for 10% of the global market. Thank you very much.

Examination of Witnesses

Witnesses: **Joanne Wheeler**, Partner, Bird & Bird, **Professor John Remedios**, Director, National Centre for Earth Observation, and **Dr Christopher Mutlow**, Director, STFC-RAL Space, gave evidence.

Q44 Chair: Welcome. Thank you for coming today and sitting through the first session. I saw you listening closely to that evidence. Can I start by asking Professor Remedios a question about our imaging capability? We heard a little about Earth observation. I think the UK is the only G8 country that does not have sovereign imaging capability. Does that matter? Does the fact that much of our data comes from overseas data providers matter to us?

Professor Remedios: There are two aspects to that from my point of view. One is that the fact that we do not have it is somehow taken by people as indicative of lack of capability, which is certainly not the case. If you look at our broader missions in Earth observation or beyond, we are very technology capable, but it is seen as a marker. The part about access to data does matter. You can acquire data commercially by buying it from any company. That is not necessarily so bad. It means that there might not be a focus on what the UK needs to grow its industry, or indeed its science. One of the points I might come back to later is the interplay between science and industry—between the research base and industry. It certainly has been very important to see our satellite producers producing imaging capability that can meet the needs of science or the market, and how you do that is perhaps by telling the Government that probably they themselves have a requirement for high resolution data in addition to the data services they get. How much they need is an open question.

Q45 Chair: I suppose that is my next question. The marker for capability is a signal we send out about whether it is important and about what we are able to do, but on the point about accessibility and what we actually need, whether in the public or private sector, would it make a difference if we had sovereign capability? Is it worth paying the money to achieve that?

Professor Remedios: I have not been privy to estimates of the cost of doing it, but I would point to the fact that it is becoming cheaper to do. If you look at the new constellations of satellites, costs vary, but in various reports you can find estimates from a few million to tens of millions. That sounds expensive, but on a satellite scale it is a lot cheaper than a big platform.

It is also the case that you want to get frequent coverage. Even if you can get the data from somewhere else, but you can contribute your own system and somehow integrate it, you can get more frequent coverage, and that is important. This is the middle of a piece of work, which I think has already been mentioned, going on across government to look at Government needs, but from a scientist's perspective I can tell you that when we are asked by Government or industry what we can achieve and so on—it might be about land use management or flooding—we are quickly in agreement that there is a time coverage gap, and there can be a spatial gap. There are some things we can do and some things we cannot do. There is a good illustration from Germany, where they have the TerraSAR-X and TanDEM-X data. They make data available commercially, and there is free access for science and for Government. It seems to work from what I see. Everyone speaks very

highly of it. We have used some of the data ourselves. Somebody wanted to know where all the highest mountains in the Andes were, and how to climb them, so we were able to use satellite data to show them what they could not see. Now they are busy climbing mountains. It gives you a new perspective that you would not get otherwise, and that is important.

Q46 Chair: You have told me about the capabilities that would be available. You have not really given your judgment about whether it is worth investing in the capability, or what you think the best solution would be.

Professor Remedios: I would not want to be drawn on whether it is worth investing, in the sense that it is a question of the cost versus how much you can get out of it. Is it a desirable capability if the cost was reasonable? Yes.

Q47 Chair: What is your view, Dr Mutlow?

Dr Mutlow: I understand why John is not answering that from the point of view of the academic community. I do not think the requirement for that capability comes from the academic community; it probably comes more from inside Government, so we are probably not the right people to ask the question in that sense. John is right that increased frequency of coverage is always an advantage for any application, as is improved spatial and spectral resolution. We always ask for it. The question is about what we are trying to do with it. If we are trying to understand processes in the atmosphere or deliver some application, you have to take the application and decide what you need for that. In the abstract, it is quite difficult for us to say hand on heart that we need such a capability, but there may well be other people who do.

Q48 Chair: In and of itself that is a helpful answer. My next question is a follow-on from the end of the previous session. I want to ask about the skills gap and the impact it is having on your sector at the moment. We understand that there have been some problems with interoperability of data, the need for sophisticated processing tools and the need for very highly skilled individuals to ensure quality of data, and so on. Can I ask all of you to respond to this question: to what extent has the effective use of Earth observation data been held back by the digital skills shortage we are hearing about from various people who have written in?

Professor Remedios: It is 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. It is not just in the digital area; there can be gaps in the engineering area and so on, but the amount of data we are getting is huge, and the ability to handle it is a big problem. In the academic research base, which includes a facility in my colleague's organisation, we have a lot of skills in dealing with data. What we lack a bit is the ability, through our degree structure and onward, through PhDs or masters programmes, to produce people we will then employ or will farm out to industry to employ. The exact reasons for that are not clear, but there is no joined-up strategy to do it. There are a number of fragmented efforts. For example, it is not clear that the research councils or the Department for Education buy into it in a big way, but that is what you need to do if you are to match the ambition set out in the innovation and growth strategy, or indeed the

ambition of the research base, which is exploring new views that we can get from space. We are doing really well at it, but people are important.

Dr Mutlow: I sit in the ground between industry, academia and Government, so I am fairly well placed to see in all directions. We certainly spend a lot of our time worrying about training people. We have problems getting people who are skilled enough to look after our own programmes: that is, engineers and data scientists across the piece. The growth of the space sector is creating interesting challenges for all of us, in that we are losing people to the companies, which is a good thing because it means we are passing on skilled people. STFC itself has recognised that big data is an area where a lot needs to be done and is setting up special schemes to try to tackle the whole issue of big data. Through the Natural Environment Research Council and John's good offices, we run large facilities where some of those large data skills can be learned. We run graduate programmes and we have apprenticeships, but more of that could be done and it is something we need to look at. Funding of the research base and pulling those skills through into industry and delivering impact is very important. We forget that sometimes when we look at the funding for space.

Professor Remedios: It is certainly an area where, for example, the research councils, which are very supportive of the research we do, could do quite a lot more. They could say that space is very important—Earth observation in our case is very important, but it could also be another satellite technology—and that they are going to take some of their existing schemes and prioritise investment in that area because it will deliver on a much needed gap. I see some willingness, but it is very slow and not coherent. I would like to see more.

Q49 Chair: Dr Mutlow, I want to follow up comments made in the previous session about the gap around early stage satellite-specific engineering, ICT and communications, because the EPSRC does not support the space sector and you only support space science. Is that something you recognise from your position?

Dr Mutlow: The Space Agency supports some very important programmes—Earth observation, instrumentation and space technology—which take things to a certain point. Quite a lot of money is available for the early stages of missions. We have to work through ESA to get our science programmes funded, and that is a very long-term exercise for a scientist who wants something delivered. In some cases, it takes five to 10 years to get a mission to fruition. Therefore, there is a need for some support for instruments to put on spacecraft within the UK. John would probably agree with me about that.

Professor Remedios: Yes.

Dr Mutlow: We have a lot of early stage development, which influences ESA and puts us in a good position with ESA, but sometimes there are things we could do better to capitalise on that.

Q50 Chris Green: The space and satellite sector is growing rapidly, which is putting more and more pressure on the available spectrum bandwidth. Ms Wheeler, is the demand hindering growth and expansion at the moment? Is there too much pressure or demand to cope with it?

Joanne Wheeler: You are absolutely right. There are growing and competing demands for spectrum, which is a finite resource, and in different sectors' various applications for it. You have already mentioned Ofcom's strategic review. Satellites in particular have increasing demand for data-intensive services. A balance needs to be struck between satellite and other applications and satellite and other sectors, and it is important for even the satellite sector to put its evidence-based case to Ofcom when Ofcom is allocating spectrum. As Stuart Martin said in the previous panel, it is an increasing problem. I do not know whether it is yet an issue. The main issue I have heard about recently is CubeSats getting access to relevant spectrum. They use amateur satellite spectrum at the moment, and it is very crowded. It is about getting access to that quickly, because Ofcom, and International Telecommunication Union processes at international level, are not known for their speed.

Q51 Chris Green: There is a certain trajectory, with demands and expectations going up and up, and we have to look to the future and think about what we need. We need a very strong voice for the space industry as a whole, but the Royal Aeronautical Society says that the space sector has been rather quiet, especially in comparison with terrestrial users. Do you agree?

Joanne Wheeler: There are two things. There are messages from Ofcom and from the space industry. The space industry is often compared with the mobile industry, and the mobile industry has a very loud and very large lobbying voice. The space industry has a smaller lobbying voice, which comes back to my point that it is very important that the space industry works together to get evidence-based criteria to Ofcom. Ofcom, however, as was mentioned by the last panel, is growing in its support for the space industry. Recently, at the World Radio Conference in November last year, it was probably more supportive than before, particularly in regard to protecting what is called the Ka-band for satellite services. There has also been an MOU recently between Ofcom and the Space Agency that allows them to work more closely in regard to the spectrum needs of the industry and to take a step closer to ensure cross-governmental support. Recently a space spectrum advisory committee—I think that is right—has been set up between industry, the UK Space Agency and Ofcom. The feedback I am getting from industry is that they feel that Ofcom is now listening to their voice. However, to answer your question fully, I do not think we are quite there yet. What is vital is that Ofcom has the right resources to understand the needs of the space industry and to represent them at international level.

When I was conducting the regulatory work for the innovation growth strategy 2010 and 2013, I interviewed most of the large satellite operators and asked, "What are your main concerns? What are you looking at when you set up or grow in a particular country?" Interestingly enough, they said that corporation tax was important but so was access—sustainable access—to spectrum and feeling that they were represented at international level by the national regulator. That is quite important. Ofcom is taking steps, but we are not quite there yet. If you will allow me to answer your question even more fully, Ofcom has published amendments to something called procedures for the management of satellite spectrum, which put quite onerous responsibilities on satellite operators—new additional milestones, which are quite cumbersome, beyond what is necessary at ITU level and beyond what is necessary to other administrations from the ITU. While Ofcom is listening

to the industry, I would like to see a consistent approach rather than very onerous requirements and procedures for the management of satellite spectrum.

Q52 Chris Green: Are those onerous expectations unique for the requirements, or the perception of the requirements, of the particular sector, or is it perhaps a crossover from the telecoms sector?

Joanne Wheeler: They are quite unique procedures for the management of satellite spectrum and what are called the filing rules at Ofcom. If you want access to spectrum, you usually make a filing through Ofcom to the International Telecommunication Union. What Ofcom is proposing is potentially more cumbersome than, say, what the French, the Dutch and the Germans are proposing.

Q53 Chris Green: In that sense, there is not international agreement or consensus on what the rules should be. Is it each country coming to its own conclusions?

Joanne Wheeler: Good question. There is international consensus under what is called the radio regulations. They flow down to national Governments, who need to pay homage to them and apply them, but they can also go beyond them. We see Ofcom, in the new proposed amendments, going well beyond them. Ofcom should be praised for trying to deal with the issue of what are called paper filings, which are filings for satellite networks without intended use. That is not in the interest of anyone in the industry, and can be dealt with at international level, but Ofcom is taking it very seriously and applying quite onerous restrictions. It is just at the consultation stage, so we will have to see what comes out when Ofcom produces a statement.

Q54 Chris Green: That is the strategic review of satellite and space spectrum use.

Joanne Wheeler: Yes, and the consultation on the procedures.

Q55 Chris Green: What do you see as a good outcome for the strategic review? What are the demands that you might direct towards them?

Joanne Wheeler: I would say a good balance of use of spectrum for space services and for satellite services, but what satellite needs, unlike other sectors, is sustainable use. If you are putting up a large geostationary satellite, you do not just need sustainable access to spectrum in the near term; you need it for 15 years. There should also be recognition by Ofcom of the strategic importance of the space and satellite industries, and their value to public services—national security, science, innovation and so on. Potentially, it goes beyond what other sectors require. Ofcom needs that holistic approach and, hopefully, the MOU with the Space Agency and the strategic advisory committee will allow Ofcom to have a more evidence-based approach.

Professor Remedios: Sustainability of spectrum use is absolutely vital for our community, certainly for Earth observation and beyond. One of the things Ofcom has been receptive to is our explaining to them why that is. Basically, from a sensing point of view, those are fundamental properties of what we are trying to observe. You have to use the correct

frequencies and, indeed, the correct combination of frequencies. Ofcom is beginning to understand that if you take a frequency out it actually has a big effect down the line. The point about public benefit—weather forecasting or whatever—has been taken as well. Ofcom has certainly been in contact with me about the evidence we produced showing the different uses of physical spectrum for physical applications, asking, “How do satellites use this?” such as diagrams and so on.

Q56 Chris Green: A telecoms industry may be allocated a spectrum that may be better or worse, but for satellites there may be certain requirements, so you need a particular frequency.

Professor Remedios: Absolutely. Given that satellites are increasingly being used for long-term monitoring of change, actually using a consistent set of frequencies over a sustainable period, a very long period, is very important. Ofcom’s international role at the World Radio Conference is, therefore, particularly useful, and it has been quite positive about that. You have to work internationally on that score.

Chris Green: Absolutely.

Dr Mutlow: What John is talking about are specific frequencies that gases or something of interest in the atmosphere emit. We also have to worry about bands adjacent to that and the harmonics of that. If you happen to be transmitting accidentally in that band, it has potential to do damage. Some of those things are very important societal benefits. We are using those frequencies because you can see water vapour in the atmosphere, or you can measure the temperature profile, which affects our ability to weather forecast. It is vital that we recognise that that has to be traded against the mobile phone operators and so on.

Q57 Carol Monaghan: In July 2014 we saw the launch of two demonstration CubeSats. I understand, Dr Mutlow, that RAL was involved quite heavily in providing the ground station for communication and control and planning those launches. Could you give us some indication of how well the technology performed during that mission?

Dr Mutlow: I am not sure that we were involved in the ground station for TechDemoSat, but certainly we were involved for UKube-1. There were some challenges with the hardware, which is one of the problems we have with CubeSats; the technology is quite immature and we are learning a lot. The mission can be regarded as a success, because it certainly demonstrated that the technology could do what it requires. One of the things that people forget when they have CubeSats is that, although the satellite itself is quite small, the level of sophistication required to control it is still pretty much as complex as it is for a big satellite, in some circumstances, and that always needs to be taken into account when we are doing these things.

As for TechDemoSat, that was an opportunity to test some space hardware. Of course, with all the kinds of things we are doing, making sure that the equipment works properly in space is one of the key things that people are looking for when we pitch a mission to the European Space Agency. Has this technology got heritage in space? Will it continue to work? Nobody wants to invest in things that will not work. Having technology demonstration satellites, where we can test out whether the new hardware will work, and

maybe that cheaper approaches to things will work, is very important to us, although satellites need to be representative of the satellites we are pitching our missions towards.

Q58 Carol Monaghan: We heard earlier concerns about small satellites in terms of controlling them, power sources, reliability and stuff like that, as well as tracking them, which is absolutely crucial.

Dr Mutlow: We obviously do that at Chilbolton, too.

Q59 Carol Monaghan: Did any of those issues materialise during your test missions?

Dr Mutlow: Not particularly. I do not think there were any issues of that kind. The whole idea of small satellites is very popular. The National Science Foundation in America has a very vibrant programme and is using them for training, but there they have a very frequent set of launches. If something goes wrong, the person gets a chance to rebuild the satellite and fly it again. Regulation is quite important. If we fly small satellites and CubeSats alongside some of the bigger satellites we fly, we can extract more value from some of the bigger missions that we are funding. That is something we are very keen on doing, but they have air traffic control problems.

Q60 Carol Monaghan: On air traffic control, if something goes wrong in terms of the orbit—if it goes into the wrong orbit—is there the possibility then to make changes?

Dr Mutlow: It depends whether we can communicate with it. We have Envisat, which is the size of two London buses, flying around, and they lost control of that; there is no chance of bringing that down. It is always very important to keep these things out of the way of the large platforms. It is now an important part of all satellite programmes that we carry enough fuel to de-orbit. It is a concern. If we confine them to the lower orbits, where they naturally decay very quickly, it is less of a concern. Certainly some of the original iridium satellites that were at a very high altitude are now decaying through orbits that we use for the bigger satellites, and that is a problem.

Q61 Carol Monaghan: When the small ones decay, will they decay sufficiently by the time they have completely gone?

Dr Mutlow: Yes. They just burn up. If you put them low enough, the drag just brings them out of orbit. That is what we do with the bigger ones, too; you have to design them so that they burn up when they come in.

Q62 Carol Monaghan: Some land in the sea, though.

Dr Mutlow: Yes, some land in the sea.

Q63 Carol Monaghan: Hopefully, not in the centre of a city.

Dr Mutlow: Increasingly, people are much more careful about it. When we fly one of these satellites now, a large proportion of the fuel we take is specifically for the purpose of de-orbiting it. Everybody is being very responsible now.

Q64 Carol Monaghan: Mention was made in the previous panel of some of the concerns about organisations that wanted to put satellites into orbit, and concerns about possibly the technological knowledge of particular organisations. Is that a fair concern?

Dr Mutlow: It is not really my area of expertise, but one would be concerned. People have to know what they are doing if they are going to put stuff in a place where it might interfere with everybody else. It is not a joke if we lose a billion-pound satellite because somebody launched a very small satellite in its path.

Q65 Carol Monaghan: I am trying to gauge whether it is a big organisation trying to stifle smaller organisations, or are there real consequences?

Dr Mutlow: No. Like anything, with sensible professional advice and certain standards, it should be safe. The regulation authorities need to be satisfied that people have competence, just the same as we have a driving licence when we drive a car.

Q66 Carol Monaghan: Maybe this is one for Ms Wheeler.

Dr Mutlow: Yes, I think it is.

Joanne Wheeler: It is an interesting industry because so many people want to use CubeSats for very exciting testing, development and so on. To answer your question, we are seeing more communications with companies that may lack experience but have a lot of enthusiasm. We need to make sure that they get the right advice from the catapult or Innovate UK and so on, because there have been a few in-orbit failures. Things are changing as experience builds up. We would not want to thwart the enthusiasm and the growth of this industry, but it needs to be mitigated, because of the risk of space debris and the risk of interference with other satellites and so on. It needs to be managed.

Q67 Victoria Borwick: That leads us neatly to asking a bit more about the licensing and insurance regulations, having heard the previous answers. To what extent do you think the current regulations prevent smaller people in the industry, or larger ones, from flourishing? What is your view on insurance and regulations?

Joanne Wheeler: Perhaps I could give a view and then pick up on the CubeSats compared with larger satellites. It is a difficult balance. I will give a tiny bit of background, to echo David Parker. The Space Agency is in an interesting dilemma. It has the duty of a regulator to manage risk and liability, control conjunctions and collisions, and to protect the public purse, but it also has to stimulate economic activity and growth and promote upstream technologies and downstream applications, which we all want to encourage. Dr Parker was slightly modest because he forgot to mention one change. They have capped the concept of unlimited liability, which obviously encourages CubeSats but also larger satellites. Previously, UK companies were not on a level playing field, because there was a

concept of unlimited liability, which, let's be honest, investors and banks do not like getting their head around, and that is now capped at €60 million. I am not aware of a regulator that has done as much in the last two years for large operators and small operators, and really tries to put them on a level playing field. The branding of the UK Space Agency and the clout of a licence is very important at international level for small players or larger players. We are not quite there yet, as David Parker mentioned.

The licence process, particularly for small start-up companies and CubeSats, is lengthy and document heavy, but by its nature it is lengthy and document heavy; it is actually rocket science. The timing for the grant of a licence is six months. That may be too long for quick-to-market CubeSats that want to get to the market early to establish their competitive position. Saying that, the Space Agency understands this and is embracing it. It has put out a consultation with recommendations that are supported by the UK CubeSat Forum. There is also evidence of financial standing, which is easier for larger operators but much harder for smaller operators, when you have to have evidence of two or three years of audited accounts. Again, in collaboration with the Space Agency, I have not seen that to be an issue. The licence fee is £6,500. If that is per satellite in a constellation, and you have 12, 24 or 36 satellites, it gets rather expensive when it is business fees for a small start-up CubeSat. Again, I am aware of one example in the UK where there is one licence for exactly the same satellites on the same launcher, and one licence fee. I appreciate that that is part of the recommendations, too. I very much hope that the UK space industry pushes forward with those recommendations.

I would like to mention two other things—insurance, which you mentioned, and ITU, the spectrum aspects. Spectrum is a cumbersome process, particularly for CubeSats. The ITU requirements and procedures are costly and time-consuming. It is difficult to co-ordinate for CubeSats and small sats, simply because they may not know the orbit trajectory, and the orbit characteristics may be unknown. That is simply the nature of a satellite. Moves are afoot at international level to do something with that. I would appreciate it if Ofcom could embrace it. To deal with your insurance and third party liability—are you happy for me to continue?

Q68 Victoria Borwick: I think so. We are probably going to be called to vote, but keep on. I won't delay you further because we are going to be voting in a minute.

Joanne Wheeler: I understand that you need to go to vote. Third party liability insurance seems to be a hot topic and quite contentious just now. It is seen as a significant barrier to entry for small satellites. It is €60 million per satellite. If you work it out, that is about 0.1%, which is about £60,000 a year for small satellite operators, so you can imagine how it could add up per satellite. Again, the Space Agency is embracing that as an issue, and looking at recommendations to deal with the situation, particularly recommendation 8, which says that if a financial assessment is carried out to look at the benefits of the CubeSat, and the risks can be mitigated and the risks are low, the third party liability insurance can be waived. It can be waived today. It does not require additional legislation. Criticisms have been made of the Government that the UK is the only one that applies this third party liability insurance. Actually, that is not the case. A report published at the end of last year said that the UK is the only state that applies third party liability. That is not the case. Austria, the Netherlands and Luxembourg do, and at almost equivalent amounts.

The only difference is the US, where third party liability is voluntary and does not apply to CubeSats.

Q69 Victoria Borwick: The only area you have not covered is the industry's take on the spending review announcement that some innovation grants would instead be loans. Is that going to restrict funding, Dr Mutlow?

Chair: Loans versus grants through Innovate UK.

Dr Mutlow: Innovate UK is very important for people in the industry, but it is not something I can comment on because I am not from Innovate UK.

Victoria Borwick: No problem. That is absolutely fine. Thank you very much. It sounds as though we may be going to vote in a minute. I wanted to make sure that we had covered all the topics that might have come up.

Q70 Dr Mathias: As we asked the other panel, what is your opinion of the Government's space policy and strategies? Do you think there is a balance between the commercial space sector and basic space research?

Professor Remedios: I am happy to comment. In the national space policy document, as opposed to what the agency does in practice, I do not think there is enough emphasis on the research-based missions. They are incredibly important and they inspire people. They achieve things. We discover things we did not know before. The UK is very successful in doing it, both in space science and in Earth observation, where I could speak more authoritatively. UK scientists led the CryoSat mission, they are leading the EarthCARE mission, and the Biomass mission to come. There is a reason for that, because those missions are important and UK scientists are good at doing it. I noticed in the previous session that there was, none the less, a little bit of separation between the research base and the industrial argument. I see them as co-deliverers in this space. It is a high technology area.

Q71 Dr Mathias: You do not think there is a problem if they are asked for a short to medium-term industrial connection with their research.

Professor Remedios: We need more support to do that. There is not enough pull-through from the research base. There are not enough joint academic-industrial programmes as opposed to one or the other. The catapult does its best, but most of its money is supporting the industry and its activities rather than the pull-through from the research base. Many companies that come to us want us to help them develop the methodologies; they can see the idea but they need expertise to help them deliver it. We do our best, but eventually you just run out of time.

Dr Mutlow: We have to remember that the pipeline for tomorrow's future commercial missions probably starts in the academic community. We are reaping the benefits today from seeds that we probably sowed 10 years ago. It is important that we keep that pipe flowing. Like John, I think we need to make sure that the research is important. It is also

important for the skills agenda, delivering skilled people who can then lead in the space industry and take it forward. I agree with John that the translation between academia and commercial impact is a tricky area. We are trying to invest a few people there. There are people delivering on the academic side and there are people delivering on the commercial side. We miss the link, and there is more we can do to make that link better. There are also some infrastructure questions about whether we need larger infrastructure in the UK, which is run for the collective but brings in some other companies, so that we can improve our economic impact. That is probably a slightly different question.

Professor Remedios: On the pipeline point, it has been very important to bring through new technologies that are really different, and to measure things that we just did not measure before. We have a gravity mission, about which somebody said, “Isn’t that just about fundamental science, blue-sky science?” We now find that people are beginning to use gravity measurements for all sorts of things that are not just academic, but related, in a way that they did not do before—water tables and all sorts of things.

Dr Mutlow: That gravity mission—the second generation gravity mission—involves cold atoms technology, which is currently under development in academia, and it will be a commercial thing in the future.

Q72 Dr Mathias: Do you agree, Ms Wheeler?

Joanne Wheeler: Yes.

Q73 Dr Mathias: Is there any problem with the funding falling between different research councils? Do you have an idea about that?

Joanne Wheeler: I do not tend to come across the funding.

Professor Remedios: The engineering point was touched on earlier, and I know that in the community it has been a big concern that somehow the research councils and the space agenda are not joined up. For instruments and sensors, given all the changes between research councils and the Space Agency, where they are sharing or passing over programmes—the Space Agency has some programmes and STFC has some programmes—they do not operate in the same way. We still have lots of uncertainty. Probably there is less confidence at the moment in the UK Government and research councils putting in the money to push the missions and the sensors forward. Who is doing what and how it is all joined up is a little uncertain at the moment.

Dr Mutlow: We are certainly using funding from outside space to try to further the space agenda. Some of the technologies we are trying to develop for space are medical applications and detection applications, to try to get money to move the technology forward to an actual space mission. There is some reverse-spin income.

Professor Remedios: They are, essentially, long term. You need long-term sustained funding at a sensible level for confidence and the ability to tell people that you are going to deliver. You cannot start a process and say, “We are not going to deliver now because we have changed our mind.” I am not saying that anyone is doing that, but there is a danger, unless you set this thing up properly, that that will happen.

Chair: I am afraid that we are going to have to bring the session to a close. Thank you all for your answers. They have been really helpful in getting us started off with our inquiry. It is a very exciting inquiry for all of us. Before we rush off to vote, I will mention for the space geeks among us, like Derek Thomas to my right, and those who have been inspired by Tim Peake's mission, that the international space station will actually be visible tonight, passing east to west over the UK, at 18.20. If you want to find out more about it, for those watching, you can have a look online at spotthestation.nasa.gov. That is vital information for all of us. Thank you very much. That brings the session to a close.