HOUSE OF COMMONS

Defence Committee

Oral evidence: Space Defence, HC 271

Tuesday 14 December 2021

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Watch the meeting

Members present: Mr Tobias Ellwood (Chair); Mrs Emma Lewell-Buck; John Spellar; Derek Twigg.

Questions 136-191

Witnesses

I: Major Tim Peake CMG, British ESA astronaut.

II: Justin T. Johnson, Senior Vice President, Meta Aerospace.

Examination of witness

Witnesses: Major Tim Peake CMG.

Chair: Welcome to this Defence Committee hearing, taking place on Tuesday 14 December 2021, which will cover space defence. I am delighted to welcome Major Tim Peake, who is not only a British astronaut but—as a declaration of interest—a personal friend. We served together, many moons ago, in the Royal Green Jackets, and from there Tim went on to work with the Army Air Corps and then, as we all know, joined the European Space Agency. I am very pleased to welcome you here today; thank you very much indeed for your time.

We are also joined by Justin Johnson, who is now the senior vice-president for Meta Aerospace, but the reason why we have invited him here today is that previously he was head of space at the Pentagon. We are grateful that he is here to give us the United States angle. We will divide our session into two parts: first, we will discuss matters with Tim Peake, and then we will switch over to Justin Johnson.

From our perspective, the space domain has an increasingly central role in modern society, and in defence as well. The increasingly congested space environment, and a rapid development in counter-space capabilities by China and Russia, pose a risk to our space-based assets and the services they provide.

The UK Government and the Ministry of Defence recognised the importance of space to defence and security in the integrated review and the defence Command Paper, and they are committed to developing the UK's defence space capabilities. We have a National Space Strategy, published in September this year, but we still await the Defence Space Strategy, which will give us more details from that perspective.

To talk about these issues and many others, I am delighted to welcome Tim. John Spellar, can you kick off the questions?

Q136 **John Spellar:** Tim, there are welcome attempts to build international consensus around acceptable behaviours in space. In that context, what are the implications of the recent Russian ASAT tests, debris from which we know threatened the International Space Station?

Major Tim Peake: Absolutely, yes. As most people would agree, we were shocked about that recent Russian anti-satellite test and, in particular, the recklessness of introducing so much space debris into an orbit at 485 km, which means that it is above the International Space Station. It is in an area where it will impact various different orbits and launch capabilities for a number of years.

It is not that I am surprised in terms of technology; Russia has had the technology to destroy a satellite in low-earth orbit using a ground-based missile system for many, many years—for decades. What it represents is

something that is not in accord with the 1967 outer space treaty, which is to avoid polluting space as an environment, and to avoid introducing debris into that environment. As we move forward, that makes it more difficult to establish international norms and behaviours in an area where space is becoming ever more congested and contested. It makes it extremely difficult to go forward in that framework.

Q137 **John Spellar:** Are there not mechanisms for dealing with such behaviour within the treaty?

Major Tim Peake: Not to my knowledge, no. That is the big problem. The '67 treaty is not fit for purpose in terms of where we have moved on to, what we are doing with commercial space activities, the capabilities that national space agencies now have, and where our critical national infrastructure is dependent on the space environment. We therefore have to protect assets. We need to look at those norms and behaviours.

It is important to consider where we have moved on from the '67 treaty in a wider geopolitical context. It is important that the United Nations remains the provider of the overarching framework for regulatory norms and behaviours that we need to adhere to.

Also, we have moved on to things like the Artemis accord, through which we are looking at how we can continue with space exploration, return to the surface of the moon and go on beyond. The Artemis accord uses the '67 treaty as a basis for its norms and behaviours, but also interprets the treaty—as regards sovereign use of a celestial body, for example.

I think we are going to find ourselves in increasingly difficult territory as we move forward. Different interpretations of the norms and behaviours will cause friction and tension, and it will require a lot of diplomacy to ensure that we all use space responsibly.

Q138 **John Spellar:** It might be desirable, but are there any moves to update the treaty, or any appetite for that?

Major Tim Peake: There is; there are moves to update it, and the UK has been at the forefront of some of those moves. Space debris is one of the overarching reasons to update the treaty, as well as how we regulate mega-constellations. It will be challenging to do that under the auspices of the United Nations, but I think it is necessary that we do.

I mentioned the Artemis accords because, with them, we now have a separate set of understandings on how we should use space, for example, as we move into the future. At the moment that has 11 signatories; China and Russia are not signatories. We run the risk of writing separate principles and guidance for how we should explore and utilise space. However, if that is not done under the auspices of the United Nations, then it is not going to be adhered to by all the necessary member states.

Q139 **Chair:** What was Russia trying to prove by doing something that, as you said, they have had the capability to do for decades?

Major Tim Peake: That is an interesting question; I do not have the answer. When you look at the geopolitical landscape, we are moving towards a very difficult area. For over 20 years, the International Space Station has provided a level of collaboration and co-operation on the civil use of space that has been, and continues to be, incredibly useful. As we look towards breaking out of low Earth orbit, and as the space station comes towards the end of its lifetime, which will be in 2030, or maybe a few years beyond—there is a limit to how much longer it can remain in orbit—we are looking at a situation where commercial space is a major player and is accelerating the pace of technological development and of space policy.

We are also looking at the next step: a return to the surface of the moon. This will inevitably mean exploitation of the resources on the surface of the moon, and then using that as stepping stone for going on to Mars. That introduces competition on where we go with space exploration. It is competition that we will see increase if Russia is not part of that same international framework, as we saw this year with the signed memorandum of understanding with China, regarding it establishing its own lunar base.

Q140 **Chair:** Going back to debris, in your time in the International Space Station, was there ever a moment when you all had to pile into your Soyuz emergency capsule because some spanner that had been left in the 1970s was hurtling towards you?

Major Tim Peake: We did not have to do what is called a "shelter in place", which is when the debris is not spotted until very late, so the crew have to go to the Soyuz and the hatches are shut on the space station to protect it from a potential strike. We did have to do a debris avoidance manoeuvre, which is when the debris is spotted in sufficient time to allow the space station to use its own thrusters to avoid that piece of debris.

Q141 **Chair:** So you had to move the space station a little bit to the left—did you then see the piece of debris go by?

Major Tim Peake: No. The pieces of debris can be exceptionally small and are travelling exceptionally fast. We do not see the debris at all. We do see evidence of small debris strikes when we go outside on a spacewalk. It looks like a .22 bullet has been fired at the space station; there will be an impact zone and, for example, sharp pieces of aluminium. We see on spacewalks that the space station is being hit by small pieces of debris.

Q142 **Chair:** You did a spacewalk; was there a concern that something smaller—a fleck of paint, for example—could come round and penetrate your suit? Are we saying that there is such a concern about the mesh of debris that it is now quite dangerous to even do a simple spacewalk?

Major Tim Peake: Space debris is a huge concern for a number of reasons, yes, and not just in terms of the threat to human life—to the crew onboard the space station, and the crew on the Chinese space station, when it is occupied. We have ground radar systems that can track

a number of pieces of space debris. However, the sophistication of those radar systems is such that it becomes incredibly difficult to track pieces of debris under 5 cm. The space station is only protected up to a maximum of 2 cm, in terms of the waffle shielding—it is like bulletproof armour plating—around the outside of the pressurised modules. We have a black zone where we cannot see it, and we will not see it coming, and it could be catastrophic to the space station. The more pieces of debris that are introduced into a conflicting orbit, the greater the risk of an impact that could be catastrophic, and not just to the space station; low Earth orbit is becoming more utilised by commercial satellites and mega-constellations. It will be part of our broadband; it is part of our weather forecasting and our earth observation satellites; and it will be utilised to an even greater degree in the future, so debris in those orbits is of great concern.

Q143 **Chair:** It seems that debris is only increasing, not decreasing. What percentage chance would you give the so-called Kessler effect of happening—the spiralling or the constellation of more mush, to a point at which no spacewalk would be possible?

Major Tim Peake: I would not be able to give you an accurate percentage of the probability of that occurring, but you are right in saying that the amount of space debris is increasing. Efforts are ongoing to reduce space debris, but those efforts will start by picking the low-hanging fruit—the easy things, like the defunct satellites that are easy to remove from orbit. Those defunct satellites are also easy to track by radar, so they are easy to avoid. The much, much harder problem is the hundreds of thousands of pieces of small debris, which we find incredibly hard to track; they constitute a major threat.

Chair: Thank you for that. Let us move on to the militarisation of space.

Q144 **Derek Twigg:** Are you concerned about the increasing militarisation of space, and the impact that that will have on international civil space co-operation?

Major Tim Peake: I do have concerns about that. I mentioned how successful the International Space Station programme had been in civil space co-operation, and continues to be. The increasing militarisation of space does cause friction in that area, and it does make it difficult.

Looking beyond the International Space Station, we have not included Russia as much as we would have hoped in the Artemis programme. I think the initial aspiration was that we would see the International Space Station partnership move forward into the Artemis programme, including Russia, and the Gateway space station in lunar orbit was going to be the initial part of that. Under the Trump Administration, the shift from a "Gateway first" approach to a "boots on the moon first" approach, which was very much US-led, did not appeal so much to Russia. Now we have this Artemis programme, which Russia is, obviously, welcome to join, but they have shown that they would rather engage with China on their lunar programme.

You have problems here with civil space, moving forward, and the militarisation of space does not help that; it just increases the level of competition that we will see.

Q145 **Derek Twigg:** What are your concerns about our continuing or future ability to harness these great space technologies to tackle and deal with the massive issues—for instance, climate change—affecting the Earth?

Major Tim Peake: I think space has a number of things to offer. First, in terms of monitoring, we rely on space-based assets for more than 50% of our climate change data. It is not just a case of being able to see the effects; it is about having that instantaneous answer to questions. Whether we are looking at methane output, CO_2, deforestation or salinity in the oceans, we now have data that scientists can get very prompt access to. That can guide political decisions, and it can provide information on how successful those political decisions may have been in trying to curb those issues.

The second, longer-term effect in space is the potential for space to provide some form of energy generation. Looking five, 10 or 15 years in the future, that is the transmission of some sort of solar-based energy system. On the 50 to 100-year timescale, it is the potential for fusion energy and the helium-3 resources on the lunar surface, for example. In the near term, it is a case of utilising space if you want a finger on the pulse of what the planet is doing right now.

Q146 **Chair:** On the collaboration between Russia and China, could you say something about the concern that these two major power bases that are not natural fits are being nudged ever closer together because of geopolitical concerns? On their current trajectory, do you see them collaborating further and getting ever closer over the next five, 10 or 15 years, leaving the west and everybody else as a separate alliance?

Major Tim Peake: I think that is a risk—absolutely. When you look at the strengths and weaknesses of those two systems in China and Russia, they have strength in their political stability over a long period and in their financial stability to be able to commit to their programmes. China's space programme has been very successful in meeting its goals on time and on budget. Their weakness is their private sector, which is not as vibrant as in the west—the US in particular.

The strengths and weaknesses are the opposite in the US. They struggle in terms of having a more frequent Administration change and a change in vision. There was, for example, the Bush Constellation programme, the Obama Asteroid Redirect mission, or the Trump aim to return to the moon. If we jump to Biden, it is still going back to the moon but, as I mentioned, it is not now Gateway first; it is boots on the moon first and Gateway will come second. Those kinds of regular shifts in policy make it very hard for industry, and even the space agencies themselves, to follow.

The strength of the west is their vibrant private sector and the pace of change of technology. You have seen the capabilities of SpaceX, for example, in being able to provide first cargo and then crew, and more

recently, in winning the lunar lander programme and delivering those capabilities. China and Russia see that private sector as a threat because their private sector cannot keep pace at the moment. They are probably 10 years behind what the west can achieve.

Q147 **Chair:** It reminds me of a misinterpretation of a conversation that I had in Azerbaijan with President Putin, of all people, when I said that there was a concern that you might be left up in the International Space Station and not given a journey back because international relations between Russia and the United States had broken down. Apologies to your family, who thought that you might have been abandoned there.

That underlines the case that we are able to park collaboration in those civil arenas, separately from international disputes, which were then focused on Crimea, South Ossetia and Abkhazia, and are now focused on Ukraine. Do you have faith that the International Space Station, and work with the Russians, can continue in parallel with whatever is being said and whatever fallout may take place between the key principals of the United States and Russia?

Major Tim Peake: When you look at the history of the success of the International Space Station programme, it has proven that it can work through political tension here on the ground, so yes, I do believe that, and it will continue until the space station comes to a natural end. My concern is what happens beyond the space station; we do not have a follow-on project where we have that area for soft diplomacy and collaboration. The Gateway would potentially be a good environment where Russia and China can still pursue their goals on lunar, as could any other nation. The Gateway could be something that everybody could utilise; it would be a highly effective piece of architecture in lunar orbit.

Q148 **Chair:** Are you slated to go up to the International Space Station again?

Major Tim Peake: At the moment, my class of 2008 are all flying two missions. Yes, there are missions in 2024 and 2025, which Andreas Mogensen and I are likely to fill.

Chair: The nation is very proud of what you have done. I will try to make sure that I do not say the wrong thing to President Putin next time I bump into him. Emma, will you take us forward on the National Space Strategy?

Q149 **Mrs Lewell-Buck:** Afternoon, Tim. As you know, our National Space Strategy was delayed, and the full Defence Space Strategy is not with us yet, although it is promised towards the end of this year. Do you think that the Government are treating the strategy with the urgency it needs?

Major Tim Peake: There have been a number of problems in producing the National Space Strategy, and that has highlighted some of the difficulties in trying to get consensus across so many different areas of Government. When you look at the National Space Strategy, you realise that it is a bit like the environment in that it touches everywhere; space touches all sorts of Departments. That is probably partly why it was delayed. There are also issues with funding. You have to have a strategy that is more than just a vision statement—it is something that can come to

fruition and be delivered. When the space strategy was published it was very welcome. It gave great ambition, vision and strategy for where we want the UK to go and how we want the UK to lead in terms of space. What we now need to see is the operational delivery of that space strategy, more clarity on how we achieve it, and an incremental approach in ensuring that we hit the benchmarks at the right time to keep on track.

Q150 **Mrs Lewell-Buck:** When industry have come before this Committee, they have been quite critical. You mentioned that the west has a vibrant private sector. In your view, are we at risk of losing some of that expertise if the Government do not release the full Defence Space Strategy soon?

Major Tim Peake: In terms of the defence strategy, obviously what you have is industry competing, needing to invest in certain areas and being able to compete in the areas where they have an interest. Yes, sooner rather than later is critical for industry, and in terms of fulfilling our ambitions it has been with the National Space Strategy as well. For example, the launch capability for 2022 has been delayed in terms of industry being able to fulfil research and development programmes, because legislation and regulation were not in place in time in the UK.

I quote an example from Skyrora—I am on the advisory board for Skyrora, which I should make clear. They have been doing their research and development programme in Iceland for the rocket launch capability, because the regulatory framework wasn't in place in the UK in time. They are still on track for a 2022 launch, which is obviously a huge success, but those delays do hinder and hamper industry. So, yes, the sooner the Defence Space Strategy can come, the better.

Q151 **Mrs Lewell-Buck:** From what you know of it so far, is it achievable and deliverable? Could the Government pull it off?

Major Tim Peake: The Defence Space Strategy?

Mrs Lewell-Buck: Yes.

Major Tim Peake: I have not had access to the Defence Space Strategy, so I am waiting to see. As for the National Space Strategy, is it deliverable and achievable? Absolutely. It will require a significant amount of investment, both public and private, and a lot of collaboration. It does lay out a fantastic vision of where the UK should look to go. It is essential that we embrace the National Space Strategy and try to make it a huge success.

Mrs Lewell-Buck: Thanks for that, Tim. We have had problems before when it comes to public and private procurement for defence, haven't we, Chair? There will be some big changes needed for them to pull it off.

Q152 **Chair:** Can I explore a bit further your reply to Emma about the regulatory environment that you think is yet to be put in place? That is denying us or slowing us down from being able to provide the launches and keep up with our competitors. Could you give more detail on what

needs to change and how fast?

Major Tim Peake: The regulatory framework is now in place. Those companies that wish to launch next year are now going through that process to acquire licences.

Q153 **Chair:** But you are saying that we were late in the day coming to that.

Major Tim Peake: We were late in the day coming to it. It has been introduced only very recently. The architecture is still such that we haven't yet seen R&D work on launch capabilities being done from UK soil. We expect that now to be in place, and those companies will be working hard to establish the 2022 launch timeframe that we have set down in the National Space Strategy.

Q154 **Chair:** So we expect to see the first launch from the UK in 2022. Is that right?

Major Tim Peake: That's right.

Q155 **Chair:** From where?

Major Tim Peake: It could be from a number of places. For example, if it is Virgin Orbit, it will be launching out of Newquay airport in Cornwall. There are a number of launch sites in Scotland that could facilitate companies such as Orbex and Skyrora for their launch targets.

Q156 **Chair:** Turning to how space is handled by Government, we have quite a traditional governmental construct here. Space is fairly new and fresh. It does not seem to sit naturally in any particular place, certainly from a defence perspective. Like cyber, it spans so many arenas. Do you think it is now right that we give it more credence and perhaps have a Minister for Space, who would be able to draw together the cross-departmental responsibilities that are required?

Major Tim Peake: Absolutely; I think that would send a strong message. When you look at the number of Departments the National Space Strategy touches, I think you are looking at about 10 or 11 Departments, so having a Minister for Space would certainly help to co-ordinate those efforts. It would have to be at the appropriate level, and I think that would be Cabinet level. That would not only send a good message to industry, academia and the scientific community, but it would also send a very strong message when we collaborate with our international partners. Having a Minister for Space from the UK attend the Council of Ministers for the European Space Agency would send a very strong message.

Q157 **Chair:** It seems that we do not appreciate the sheer importance of the space domain in how we communicate, do business, travel, socialise and defend ourselves. Do you think that there is still a little bit of learning for Government to do in order to take stock and appreciate just how vulnerable our connections with space are, but also that there are opportunities for us to move into this fast-changing arena?

Major Tim Peake: I think so. It is a very exciting arena—looking at how it can impact on the UK economy and the UK skills force for the future.

There is a lot to be done, and what is interesting is that we are coming from a position where we have not been as involved in space over the past couple of decades as some other countries, in terms of our funding and ambition. Now we are in a position where we are accelerating rapidly in that area, which is great to see, but it is also a huge potential area for growth. While we may not have the expertise in launch capability that France have with their Ariane, that Italy have with Thales Alenia in terms of their space manufacturing, or that Germany have, we can embrace new space. We can get involved in areas where we have world-class capabilities in terms of telecommunications, small satellite manufacturing and solar panel technologies, and we can look to the future for things like in-orbit servicing and additive manufacturing technologies. With these kinds of things, the UK can really establish itself as world leaders for a space economy.

Chair: I know this is something that you are passionate about, because you are an ambassador for science, technology, engineering and maths, or STEM.

Q158 **John Spellar:** Exactly right, Chairman. We are talking about using the wonders of space to attract young people into STEM careers. What would you say have been the highlights of the work you have done on STEM with children, and are there any particular initiatives in this area that you would like to see the Government provide more support or publicity for?

Major Tim Peake: Yes, absolutely. In terms of STEM, you quite rightly said that space is a fantastic hook to embrace the wonder of what we do in space and exploration and then say, "Okay, how do we channel that into the areas that we would like young people to be focusing on?" When we looked at the Principia mission to the space station in 2015 along with the UK Space Agency, we laid down a programme of educational outreach activities that embraced not just STEM, but things like art, drama, literature and music, using space as the hook.

We have found that space is an incredibly inspiring topic. We have engaged with over 2 million students based on those Principia outreach programmes, and many of those are still running. For me, the highlight is seeing the impact of mission Principia in the classroom—space now being on the curriculum and being an area where people can get involved—and helping them to develop careers for the future.

Where we need to improve now is that we now need to look at this holistically. We find that we are able to influence at a young age, which is great, and that carries on into GCSEs. We have seen a big uptake in STEM-based subjects at A-level as well, particularly with female students, which is great for trying to improve diversity in the engineering and space career workplace. We need to focus on the skills gap, in terms of what are industry's needs and is our education system matching them adequately? The pace of the space industry, and engineering and technology in particular, is such that the education system sometimes struggles to catch up. You'll have a company that has a demand for people with skills in computer-aided design and artificial intelligence in additive manufacturing

techniques, yet people are coming out of an education system that has not quite prepared them for that workforce.

I have been encouraged to see the Government's proposal for T-levels; on paper, that looks like a very exciting opportunity to do something where you can engage with industry at an early age, yet if you decide not to go into industry at 17 and 18, a T-level does not stop you going to Oxford or Cambridge University. If you get a distinction at T-level it is seen as equivalent to three A*s. That is a very good way of offering young students the option to engage with industry at an early age, to try to give them the information they need, and for industry to help shape the education sector. I would like to see the Government put a lot more emphasis on making those T-levels available and successful.

Q159 **John Spellar:** How receptive is the education sector to feedback from industry on their requirements both now and projected into a fairly near future?

Major Tim Peake: I don't have a huge amount of evidence on how successful that is, but when I have been to places such as university technical colleges, it has been extremely well received. I visited Portsmouth UTC not too long ago and saw how industry is incredibly involved in the curriculum there. That has been well received by that education sector in terms of really tailoring the workforce and giving them the skills they need for success.

Q160 **John Spellar:** You mentioned earlier that space was a great gateway for getting youngsters involved in STEM. But now, with those who have STEM qualifications, there is a huge range of opportunities opening up in other areas. How does the industry maintain their interest in going through into the space industry?

Major Tim Peake: That is a challenge; it has been a challenge we have faced for a long time. For a long time, some of our brightest minds in technology, engineering and STEM have been snatched up by the financial sector or other areas of tech that can offer greater salaries. That is not a new challenge, and it is one that the space sector can address because of the ability to innovate, to be creative and to be at the cutting edge of some very exciting programmes. That is where we will entice young people with the necessary skills into the industry, because it is a vibrant and exciting area to be working in. I think a lot of people see that as well.

It was interesting, when my two colleagues Bob Behnken and Doug Hurley flew on the first SpaceX, which took them to the International Space Station, that there were more people watching that happen on NASA TV than were watching any other TV channel in the world at that time. That gives you an indication of the flavour among young people—to be involved in something that is exciting. That is where the space industry is going to be able to compete with the higher salaries in other sectors.

Chair: John, thank you very much. Derek, do you want to take us forward on this?

Q161 **Derek Twigg:** Going back to space debris, you mentioned that we tend to go for the low-hanging fruit—the bigger stuff—and that getting the smaller debris is difficult. What technological innovations can deal with the smaller debris? What is out there? What is possible in the next few years? I am not sure we got into that bit of detail.

Major Tim Peake: The challenge is that the smaller the fragments, and the more multiple they are, the harder they are to capture and recover. You are then looking at, potentially, a number of different technologies, such as some sort of net-based system literally to try to capture them and sweep them up, as opposed to the harpoon systems that are being envisaged at the moment to capture the larger satellites.

Q162 **Derek Twigg:** Actual nets of some sort?

Major Tim Peake: Some sort of space net-type system in order to do that. If there are metallic pieces, you could have some sort of magnetic attraction system. Various technologies are being explored at the moment, and something that could improve that in the future is the onset of in-space manufacturing—another capability that is, I think, mentioned in the National Space Strategy—because once you start in-space manufacturing, you are able to assemble much, much larger structures than you could otherwise launch into space. If you are talking about a kilometre square array net system, for example, that is something that would be easier to manufacture in space than to launch into space.

Q163 **Derek Twigg:** How far away are we from that technology? Have we actually got it at the moment or is it going to be five or 10 years—

Major Tim Peake: I think, in terms of in-space manufacturing, we are going to see an acceleration over the next 10 years, but I think we are 10 years away from seeing that kind of technology.

Q164 **Derek Twigg:** Okay. The original question that I was going to ask you was about the MoD. How does the MoD make long-term careers in space attractive to military personnel?

Major Tim Peake: I think that, from an MoD perspective, space is being seen as an attractive career because of it being at the forefront of a lot of new technologies and at the cutting edge of what we are capable of achieving, but also in terms of being able to work with industry as well. There are some novel ways in which Space Command can make it more attractive in terms of—

Q165 **Derek Twigg:** You mean cross-postings—working with industry and other potential partners of the branches of the armed forces.

Major Tim Peake: Absolutely—both within the MoD and with industry. They are the kind of cross-postings that enable people within the MoD to see themselves following a career path that is not only exciting and interesting at the time; they can also see that it is providing them with skills for the future. That is always going to be attractive to anybody serving in the MoD. If you offer industry placements, that is obviously enhancing people's career development and their skillset.

Q166 **Derek Twigg:** And attracting people into the armed forces with that sort of focus on space is a way we could be going in the future?

Major Tim Peake: One of the greatest things that attracts people into the MoD is the fact that the level of training that they can be offered is exceptional, in terms of the courses they can go on and how they can develop and progress their career. So I think that is somewhere that the MoD will have a great strength in terms of being able to grow and train their own workforce.

Q167 **Chair:** Your career path is interesting, in that you were in the military and then moved to the civvy side of space. As a Committee, we are now looking at how we bolster, or what we need to do to emphasise and strengthen, our military space capabilities. Can you say whether we are moving fast enough? The United States is probably the best exemplar, but I think France, too, has introduced a space force in some form. It sounds a bit Star Trek-y, Star Wars-y, but nevertheless Russia is now including space doctrine in its military protocols, and that is understood, because the ultimate high ground has now shifted. If you take out the satellites and start doing harm up there, it will have a knock-on impact on what is happening below. So where do you see the UK military space capability developing and are we moving fast enough?

Major Tim Peake: I see UK military capability developing in terms of protection of critical national infrastructure—the assets that we currently have in place and that we are going to have in the future. That is absolutely vital. It is also in terms of the ability to work with our allies and to complement the capabilities of some of our larger allies, such as the United States. Working with them in that sort of complementary framework is going to be important as well.

Are we moving fast enough? It is obviously great to see Space Command up and running. We are looking at having the national space operations centre, and the Defence Space Strategy coming out. So we are moving at pace. We are probably a little bit on the back foot in terms of when we started, but we are certainly moving at pace, and I think that we will accelerate and get to the stage where we need to be in a very short period of time. Where we will have to focus our attention, I think, is on maintaining that skills force for the future—that is not just on the defence side, but on the civil side as well—in looking at that future workforce and making sure that we continue to grow our workforce so that they have the capabilities that we need.

Q168 **Chair:** How vulnerable is our economy if things in space were to go wrong—if GPS were suddenly switched off? First, is that something simple that can be done? Can a rogue nation choose to do that, either by taking out the ground systems or, indeed, with a kamikaze-type satellite to deliberately disrupt? In other words, an asymmetric form of causing economic harm to the western world.

Major Tim Peake: Yes, there are a number of threats, both soft and hard. Obviously, we already see a number of cyber threats on space-based assets every year, and that is something that could disrupt the GPS

position navigation timing signals. We have seen that nations have direct impact threats as well—kinetic impact threats from ground-based missile launches—so that is a threat as well, plus the fact that there is the potential for an in-orbit threat.

The GPS signals are weak, so there is a spoofing threat there as well—a temporary interruption of signals; a disturbance—and we now need to think about resilience and think about our critical national infrastructure. Whenever we build a system on the ground that is reliant on PNT, we need to think about resilience and redundancy in terms of "If we do lose that PNT signal, can it still operate in a redundant mode? Can it still provide a service, maybe a reduced service, but one that is at least operable in a redundant fashion?" rather than just ploughing ahead and always assuming that that PNT signal is going to be there.

I also think that is why we need to consider very carefully whether the UK should be allocating funding towards having its own PNT system—for example, second-generation OneWeb. Is that a sufficient platform to have, if not fully operational PNT, at least some form of capability that we have a sovereign capability for?

Q169 **Chair:** That is interesting, because firstly, OneWeb is a different orbit, isn't it? It is a much lower Earth orbit, therefore you need more of them, and I do not know where we are. We are looking at that, and it will be part of this investigation as to whether this was worthy spend by Government to bail out a company that, I think, was actually going down—whether this was a worthy investment or not. So, you see OneWeb as being a potential complementary GPS capability that could be sovereign-based.

Major Tim Peake: W should definitely explore that capability, yes. It is in a low Earth orbit, but it is not as low, for example, as the Starlink constellation, so it has the ability to provide broadband communication. You are quite right that it is not in the same high orbit that the current GPS systems utilise, but if we are talking about resilience and redundancy, even if it cannot compete in terms of providing the capabilities of the current PNT, can it provide the UK with a redundant operating system?

Q170 **Chair:** I use Galileo as a regular example of how Brexit perhaps disrupted the politics of working together with space. You talk about us having a more sovereign capability: is the Galileo project something that you think would be worth us participating further in, if we could?

Major Tim Peake: Well, in an ideal world we would still be part of the Galileo project, having invested a huge amount of money, and also in terms of our expertise in terms of Surrey Satellite being at the heart and soul of some of the technologies that were involved there, and many other companies as well. So, yes, but that is obviously a political decision, and one that I am not really an expert in answering.

Q171 **Chair:** No, I was going to leave that optional, as to how far you wanted to go down that particular cul-de-sac. It is interesting that India, for example, has a regional GPS system. They don't bother with the whole of

the world. That could be one question—for us to have a system, Skynet for example, that simply hovers roughly in a geostationary orbit above the UK, at least allowing us to continue data operations in the worst-case scenario where GPS or BeiDou falls apart.

Major Tim Peake: Absolutely, yes. Again, that is why I mentioned second-generation OneWeb. Perhaps that could provide a similar, limited capability—something better than nothing.

Q172 **Chair:** Right. Good. Any further questions from colleagues? No.

Tim, thank you very much indeed. We very much appreciate your time today. We are very grateful for what you are doing to further the interest in science, particularly among the younger generation, and for being an exemplar of where you can end up in the armed forces. It is absolutely fantastic to see you here today. I very much appreciate your time. On behalf of the Committee, thank you very much indeed.

Examination of witness

Witness: Justin T. Johnson.

Q173 **Chair:** Welcome back to this hearing of the Defence Committee, where we are focusing on space defence. Thank you very much to Major Tim Peake. We now turn to Justin Johnson. Thank you. Can I invite you to say a little about your experience at the Pentagon, to explain your background and where you are today?

Justin T. Johnson: I was fortunate to spend a few years in the Pentagon. I started on Capitol Hill, so I appreciate the honour of speaking to you all this morning and the process you are going through. At the Pentagon, I helped run a cross-functional team for the Deputy Secretary of Defense that looked at space organisation and space capabilities. That was driven by Congress' desire and bipartisan interest in moving space capability faster. I ran the team that helped figure out what our different organisational options were, which resulted in Space Force. We were also looking at specific capabilities. At the tail end of that, I ran the space policy shop for the Pentagon. I had the good fortune to work with some UK colleagues and others around the world on advancing the space agenda.

Chair: Thank you very much. Derek, do you want to take us forward?

Q174 **Derek Twigg:** It is nice to speak to you. The US has until recently enjoyed military dominance in the space domain. Do advances by Russia and China now threaten that dominance, and are the US and its allies doing enough and moving with sufficient pace to counter that threat?

Justin T. Johnson: That cuts to the core of the question. I think the US and our allies to some degree took our eyes off the ball. We had a couple of decades of uncontested advantage in space, and I believe that particularly China and Russia both saw that space was a critical enabler for our ability to project power around the world. They systematically thought through how to disrupt that capability in multiple ways and in multiple

orbits—kinetic, non-kinetic, reversible, irreversible. Today—and certainly recent events continue to bear this out—China and Russia both have the ability to significantly negatively impact the US's space capabilities, and allies' and partners' as well.

I think the short answer to, "Are we moving fast enough?" is that I do not think we are, as an alliance, a group of free nations. I am happy to get more into this. I think we have the underlying competitive advantages to endure and stay ahead over the long term, but in the short term we have lost a step, and our competitors and adversaries are moving faster than we are.

Q175 **Derek Twigg:** You touched on this, but Chinese defence academics have highlighted that attacks on information systems, including satellites, will play a crucial role in "blinding and deafening" the enemy in the event of conflict. How do we best mitigate that?

Justin T. Johnson: There is a deterrence side of it, which is probably worth thinking about but is also hard to execute on. On the capabilities side, the focus that I know your and others' efforts have come across is resilience. You can achieve resilience in multiple ways. There is resilience in space through layers, proliferation or multiple systems that you can use in different times and places. There are levels of resilience, where you say, "Are there ways to do a mission without even going to space?". For example, communications using long-endurance UAVs is a way to mitigate the risk of loss of communication from space. What we need to be building is a combination of deterrence and resilience. Both of those rely on having the technology, capabilities and people—essentially, the economic power, the space economy—to do those and stay ahead.

Q176 **Derek Twigg:** So, basically, we have to be worried about the Chinese catching up and overtaking; we have to remain a step ahead.

Justin T. Johnson: Absolutely. The Chinese in particular have built a multi-year programme specifically aimed at being able to blind and deafen free countries.

Q177 **Mrs Lewell-Buck:** Good afternoon. Actually, it is morning where you are, Justin, isn't it? Good morning. As you know, the UK has been leading on efforts to develop an international consensus on norms and behaviours in space at the United Nations. In light of China and Russia opposing the UN working group to take this forward, and last month's Russian ASAT test, is it realistic to think that a consensus can ever be reached?

Justin T. Johnson: That is a great question. First, I commend the UK for leading on this effort; I think it is critical in many different ways. I think your question is also very realistic. I do not think that Russia or China are going to just fall in line with responsible behaviour and norms that are proposed by the UK or her allies, but I think that doesn't change the importance of the effort.

We collectively need to model what responsible behaviour in space looks like. First, if there are countries on the margins that build capabilities and

consider whether to pursue a reckless approach—like Russia with its recent ASAT test—or a responsible approach, we want to be able to articulate what that responsible approach looks like.

Secondly, I think it is important to articulate what responsible behaviour in space looks like so that we—all of our partner and ally countries together—can call out irresponsible behaviour when we see it. We can say, "This is what right looks like," and you are not following those norms. It is very important that we push forward, even if China and Russia continue to be reckless and irresponsible.

Q178 **Mrs Lewell-Buck:** Thanks for that. I want to explore this with you. Do you think the US is fully committed to developing a consensus, bearing in mind the current shift towards acknowledging space as war fighting, rather than merely operational? Does that suggest a different shift?

Justin T. Johnson: There is a tension between talking about a war-fighting domain and advocating responsible behaviour, but I think that tension exists in every domain in which humans move and occupy. I think we would say that cyber is a war-fighting domain but that does not mean we cannot do the responsible things, and articulate for what that looks like.

The same is the case historically in air and seas. There is certainly a tension there; I think it is unavoidable. We have to manage it and move forward with articulating responsible behaviour, but also being prepared to defend our interests in the domain of space.

Q179 **John Spellar:** Both the US and UK Governments have recently released space strategies that commit to deepening allied co-operation in the space domain. From your perspective, what outcomes should they be seeking, both in the long term, but also any quick wins that they could achieve now?

Justin T. Johnson: First and foremost, the UK and the US space strategies are clear on this. Within the space community sometimes there is a tendency to think about space for space's sake. It is cool and exciting, but I think we always have to bring it back to earth—pardon the pun—and remember that space is ultimately about exploration and a number of things, but it is economically driven. The primary reason we are interested in protecting ourselves in space is to protect our economic interests in space.

Similarly, the way we protect ourselves in the long term is to grow our economic space power, if you will. The long term has to remain at the core of what we are thinking about. Otherwise, it turns into a lot of individual, tactical pieces. It has to be about how we build the economic power and the structures that come with that. As for near-term wins, building on the last line of questioning, probably the area where there is continued near-term effort to produce real results is in the allies and partnerships arena.

Both on the civil side and the security side there is some momentum that is growing. There are bodies like the Combined Space Operations forum,

which has the US, UK and others in it. There are world-leading bodies, multinational organisations, that cut across security structures in a way that no other organisation does—not NATO or individual partnerships. That is where leadership is happening, in the multinational forum on space. Doubling down and encouraging those is at the top of my list of things that we need to work on.

Q180 **John Spellar:** That is encouraging, but let's look at possible hurdles. One of them is information sharing, where the US defence space strategy undertakes to improve information sharing with allies on space. In reality, the lack of shared history between the Space Force and its allied counterparts is one of the issues that could present a barrier to that. Is that correct in your experience? How might that and other potential obstacles to information sharing be addressed?

Justin T. Johnson: I agree that information sharing has been and remains a hurdle for allied and partner development and co-operation. It goes back to many decades of space being, in my opinion, over-classified in the US and largely US-only. I think the Pentagon and both the current and previous Administrations have all articulated that as a goal—it is good that there is continuity about that being a goal—but the proof is yet to be seen. We need to be either downgrading or increasing co-operation opportunities. Some of those things can happen without them being fully publicly discussable; there may be things in progress, or expanded co-operation going on, that we cannot talk about in this forum, which I think is important. Overall, we absolutely need to be able to normalise space, including being able to talk about it and share information more readily across national boundaries.

Q181 **John Spellar:** To take one other aspect of future work, were you slightly surprised that the Australia, UK and US security pact made no mention of space? Given the involvement and mutual dependency of all three countries on space operations, do you think there is scope for increased co-operation?

Justin T. Johnson: That is a great observation. I think that any opportunities for co-operation should be considered and sought after. I think the Combined Space Operations Forum, which has the UK, Australia, the US and others, is already doing this sort of co-operative work; it also pulls in a few other key partners, such as France, Germany, Canada and New Zealand. It is still a relatively small group, but it encapsulates more of the space powers that we have today. My recommendation would be that, if we want to add more energy to alliance and partnership building in space, we should focus on growing existing structures in the CSpO, rather than trying to add it to AUKUS going forward.

Q182 **Chair:** I want to look at the gaps in allied space capabilities. You would probably place the United States in the top tier. Of its nearest peers and allies, Australia, the United Kingdom and Italy were mentioned, along with the Emirates and others. Could you, in a crude way, arrange us into our league positions?

Justin T. Johnson: I am happy to take that one, although it may be a little bit dangerous. I would certainly put the US at the top; I think in the second tier would be France—I would put France second—and then there would be a tier 3 that would include Australia, UK, Germany, Italy and Japan. It is completely subjective, obviously, but it is a combination of space security capabilities and civil space capabilities that I think often go hand in hand.

Q183 **Chair:** That is helpful. So that I understand, what is it that France is doing that Britain isn't?

Justin T. Johnson: They have a history of leaning forward in space and making significant investments in capabilities such as ISR, communications, EW and SIGINT. They have also been more aggressive on space security, establishing a space force—or rather, renaming their air force an air and space force. I think they have delivered more capabilities more rapidly than almost anybody else.

Q184 **Chair:** When we are speaking about space security, is there enough collaboration? From a conventional perspective, NATO is now looking at cyber a little bit, but is this bleeding into the arena of space as much as it should do, given what China and Russia are up to, as you touched on? Are we still too siloed at the moment?

Justin T. Johnson: I think we are still quite siloed, and we are probably still in the early days on space. Particularly on the uniformed side of the house, I would say that there are growing partnerships across a number of these partner countries. NATO is increasing its capability. On the civilian side, there is certainly room for growth. Where I have seen it repeatedly get stuck is not so much in military officer to military officer co-operation, but rather when we get into the legal, political, diplomatic and commercial questions that are often core to complicated space issues.

More effort is needed. I commend you and others for leading on this. I think a number of these issues become issues that Congress, Parliament or others need to help wrestle through. At times you have to decide whether you are preferring defence, commerce, civil or exploration in a given mission set and on a complicated issue. I think the senior leadership needs to continue to spend more time and look for more senior level opportunities to engage across partner countries to keep things moving.

Q185 **Chair:** You can avoid this question if you want to, but can you give us an indication as to which nations you believe have either dual purpose or primary weapons in space?

Justin T. Johnson: Clearly Russia and China have proven themselves repeatedly—even in recent days with Russia. Beyond that, it gets more complicated. To protect my history of having clearances, I should not say too much on that.

Q186 **Chair:** That's understood. Let's stick with the adversaries. We recently saw Russia take out its own weather satellite, but that was ground-based or air-based. I am specifically talking about space-based weapon systems

to cause harm, either through electromagnetic capabilities, kamikaze or whatever. Could you expand on how you see Russia and China in this arena?

Justin T. Johnson: Absolutely. China and Russia both have well developed multi-layered anti-satellite or counter-space capabilities development programmes. China tested its LEO anti-satellite missile in 2007. Later it tested a GEO anti-satellite missile. It also has space-based capabilities. I would characterise China as having at a high level spent more effort on countering geosynchronous orbit capabilities. That makes sense, because China is looking at the western Pacific, where communications will be a key element of any conflict. A lot of those capabilities reside in GEO.

Russia has focused comparatively more of its efforts in developing counter-LEO capabilities. Again, I think that is consistent with how Russia thinks about fighting and what would be important in a conflict. Both countries have reversible and irreversible capabilities, with things like jamming, cyber, dazzling and spoofing. I think probably one of the ones that everyone in the US national space community worries about is cyber. Protecting against cyber-attacks and space capabilities continues to be undervalued and under-prioritised. This whole range presents a range of options for the adversaries to blind or deafen the US and her allies.

Q187 **Chair:** Thank you for that. Can you talk a little bit about overt space structure? I think it was President Trump who launched the Space Force. Can you describe how it works in practice? How big is it, and what is its remit?

Justin T. Johnson: Absolutely. Interestingly, President Trump should and does get a fair amount of credit, but there was a bipartisan effort in Congress that actually started it even before President Trump had gotten into it. I think the reason for it all to build momentum and actually move forward was the clear sense publicly and in classified sessions that China was moving far faster in developing counter-space capabilities than the US able to respond. The threat was driving the whole conversation. As we did the analysis to think through what needed to change, we came to three key pieces that we thought any organisational, structural changes need to address.

We needed to elevate leadership so that there was senior civilian and uniform leadership with a background in space. We thought about doing that in a variety of ways so that, when a space event occurred, the Secretary of Defense or the President had a four-star general and an equivalent civilian that he or she could turn to for advice.

The second key concept was consolidation. We had space scattered across the enterprise just within DoD. Every force—army, navy, air force, marine corps—had space capabilities, plus the National Reconnaissance Office, plus other things. The space acquisition and development enterprise was fractured, so we wanted to consolidate that.

Thirdly, underlying both previous points, was acceleration: how do we drive faster delivery of capabilities to protect our vital interests? Hopefully, accelerating is an output of elevating and consolidating. However, we also took the separate step of creating the Space Development Agency, which was a completely different approach to acquisition—to run fast and be a competitive force inside the space system for trying and delivering different things.

In the end, we ended up with the Space Force, which, like other military services in the US, is charged with organising, training and equipping: preparing the force for today and the future. Space Command, which does the actual operational piece, is responsible. Its AOR, if you will, is 100 km and beyond; it is the largest command by geography, which it will happily tell you. The Space Development Agency is the last piece of that. I would say that they are all are at different stages of growth. There are certainly some inefficiencies in how we ended up with that system, but I think we have successfully added a lot of energy to the space enterprise in the US.

Q188 **Chair:** And has the Space Force taken over Area 57?

Justin T. Johnson: You would have to ask them.

Chair: Is that classified? Okay, thank you.

Q189 **John Spellar:** We have gained the impression that the establishment of the Space Development Agency signalled a radical change from traditional defence procurement models. What problem was the SDA intended to solve, and how successful has it been in achieving that?

Justin T. Johnson: The problem we were attempting to solve was that, as defence acquisition experts in the US who are far smarter than me would tell you, there are usually three factors in an acquisition programme: speed, cost and requirements or capabilities. You have to pick two out of the three. You can't get all three in any acquisition programme.

Unfortunately, I would say that the only consistent things in the recent history of space acquisition in the US are that the cost will be over estimate and the speed will be far slower than originally planned. The question was whether we could make incremental changes to existing space acquisition organisations that would produce results fast enough, or whether we needed to create a whole new entity to try something different. After a long and exhaustive series of conversations, we decided to do both. We would try to make changes to what was then the Space and Missile Systems Center, or SMC, in Los Angeles, and the overall space acquisition enterprise. We would also set up a sort of competitor, for lack of a better term, that would be specifically focused on leveraging new space and on speed over basically anything else because the consistent theme in the threat analysis was that our adversaries are moving fast and we aren't. All those organisational changes need to change that equation, so speed was really the driving force in creating the Space Development Agency.

Q190 **John Spellar:** Has that therefore been more effective at basically downselecting the winning formula early and then moving fast with that?

Justin T. Johnson: I think the signs so far are encouraging for SDA. They are downselecting quickly; they are leveraging the commercial space enterprise that we have here in the US to buy faster and cheaper. The systems are not in orbit yet, so it will probably be another year or 18 months before we can know just how effective, but I think the signs are encouraging. They are moving probably an order of magnitude faster than almost any other part of the US national security space ecosystem.

Q191 **John Spellar:** Within that, from what you are saying, they seem to be getting the right balance. They've been taking an element of risk in procuring new technologies but have also ensured value for money. Is that the view of the accounting officers too?

Justin T. Johnson: I have not seen the latest internal analytics on the Space Development Agency. I think that striking the balance, between risk and confidence that every dollar—or pound—will be spent appropriately, is a constant challenge and, I would say, historically in the US, we have tried to avoid capability risk, and that has produced huge amounts of financial risk. As I mentioned, almost every space acquisition programme has been over budget.

If you are picking two out of those three options, the SDA has bias towards speed and costs as being the driving factors. That means that they are willing to accept a lower level of capability now, and trust that over time, they will upgrade, versus trying to get the capability 100% correct. Again, I have not seen the latest financial analysis—that's internal—but I think, in general, they are on the right track.

Chair: Thanks very much indeed, Justin. I think that brings our questions to a conclusion for this fascinating session, which we are only just beginning to understand and explore. I am still coming to terms with the fact that you placed us in tier 3 of the space capabilities. It is something to drive us to move forward. We are really grateful to you for contributing to our studies today. My thanks to you and to Tim Peake, for this sitting. That brings to a conclusion today's sitting. I am grateful to my Committee and to all the staff here.