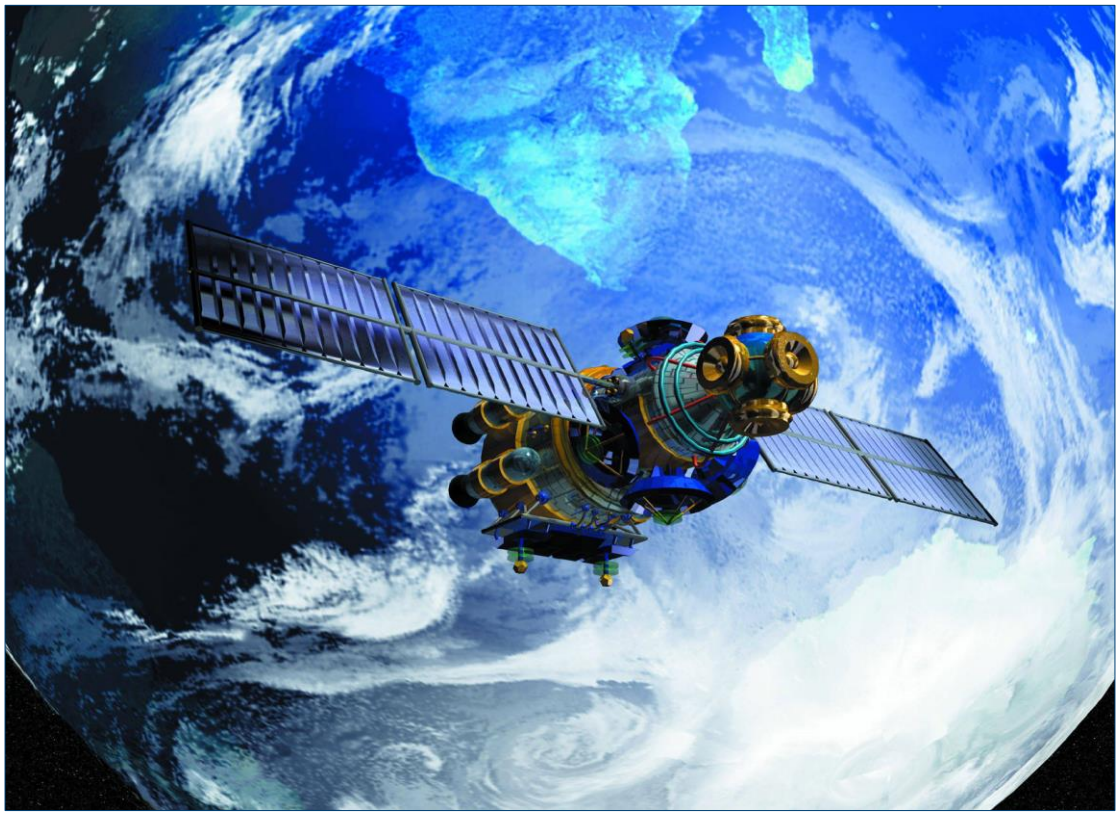
Foreign & Commonwealth Office

Wilton Park



Report

Governing space activity in the 21st century

Monday 13 – Wednesday 15 March 2017 | WP1526

In association with:

AIRBUS

Federal Foreign Office

Secure World Foundation

Wilton Park

Report

Governing space activity in the 21st century

Monday 13 – Wednesday 15 March 2017 | WP1526

This conference set out to bring together representatives of government, industry, and the scientific community from developed and developing nations to assess the prospects for improving the governance of human activity in outer space.

The economic security of countries is increasingly reliant on space-based technology and activities. There has also been a significant shift towards industry, rather than government, being primarily responsible for activity in space. Lines between commercial, government and defence systems in space have become blurred, and unilateral space activities are being replaced by bilateral, regional and multinational activities.

The growth in human space-activity, coupled with the increased diversity of space operators, makes it both more complicated and more necessary to develop new norms and rules governing human activity in space. This conference set out to hear from a diversity of stakeholders on this topic with a particular emphasis on the voice of industry from emerging and established space faring nations.

Conference objectives:

1. To engage an international network of technical experts and policymakers to promote informed decision making, responsible behaviour and to share best practice and ideas.
2. To identify the areas of space activity where greater international cooperation is most needed, analyse potential pathways towards formal agreements or treaties, and assess risks and opportunities from a multisector perspective.
3. To work towards creating a more comprehensive rules-based framework on space activities that can underpin behaviour, build trust between state as well as non-state actors, and create a formal set of norms for space to guide future developments.

"need to establish clear, international guidelines to ensure the continued sustainability of this environment for all"

Introduction

1. The space sector is experiencing a profound change. The exploitation of microelectronics and adoption of mass manufacturing techniques is decreasing the cost of building satellites, while an increase in demand for space launch services is also driving innovation in that sector too. As a consequence, space activities are far more affordable, giving birth to a wonderfully diverse and exciting range of novel space platforms and services and making space much more accessible. This new era has prompted a number of nation states to become space actors and encouraged many commercial companies, scientific organisations, and universities to build satellites and

conduct space experiments. The economic potential of this sector is enormous. The first section of this report seeks to capture the range of actors and services. This cannot be a comprehensive list as we are only at the foothills of the new space domain but it should provide a flavour of how rapidly the market is expanding.

2. Moreover, the international nature of space does present some inherent weaknesses. Any one actor might deliberately or unintentionally pollute a particular orbit, thus reducing access for all. The following section examines some of the risks to space operators, specifically, the growing problem of tracking objects on orbit, which is exacerbated by both space debris and the proliferation of satellites; radio frequency interference, both deliberate and unintentional; and concerns about military capabilities that could threaten space assets.

3. This brings into sharp focus the need to establish clear, international guidelines to ensure the continued sustainability of this environment for all. This could include a commonly accepted Space Situational Awareness (SSA) picture, agreed policies on the mitigation of space debris, agreed policies on the removal of space debris, and better tools to tackle radio frequency and electro-optic interference. The existing framework of international law is some fifty years old and needs to be updated in order to better reflect the features of the new space environment. However, there is little agreement on what the priorities should be and any renegotiation risks undermining the existing framework. Instead, the international community has sought to establish Transparency and Confidence-Building Measures (TCBM) such as those proposed through the 2013 Group of Government Experts' report on space TCBMs to the UN Secretary-General or the Long Term Sustainability (LTS) guidelines proposed by the UN Committee for the Peaceful Uses of Outer Space (COPUOS).

4. The conference dialogue produced 15 recommendations for the space community moving forwards, suggesting 5 TCBMs, 5 practical/technical proposals, and 5 suggestions to improve government/industry relations. These can be found in the penultimate section of this report. Some final comments and areas for further work can be found in the conclusions section.

The new space environment

"As of the end of 2016, there are 84 members of UN COPUOS, and therefore nations with an interest in space governance issues"

5. Space is now one of the fastest growing sectors globally. According to the Space Foundation, the global space economy generated US$323bn. It is estimated to reach $500bn by 2030. Katherine Courtnay, Director of the UK Space Agency speaking at the Space Finance Network in March 2017, stated that in the UK, space is now growing at four times the rate of the economy and is 2.7 times the national average for productivity. The UK space economy generated £13.5bn in 2016 but looks to grow to £40bn by 2030.

6. As of the end of 2016, there are 84 members of UN COPUOS, and therefore nations with an interest in space governance issues. This number is likely to rise as the costs of space use continue to fall: Costa Rica, for example, is launching its first satellite in 2018. There is also help available for those emerging nations who would like move into this sector: British firms SSTL and Clyde Space have provided a variety of nations with small satellites; Japanese universities have been working with Bangladesh, Bhutan, and the Philippines; and China has built and launched a number of satellites on behalf of other nations and recently signed an MOU with the UN to provide Chinese Earth observation (EO) satellite data to other nations.

7. According to the Space Foundation, over 75% of activity in space is now conducted by the commercial sector. The commercialisation of space has been particularly prolific in US and Europe, although US national programmes and EU/ESA programmes remain important customers for those industries. Larger Asian states, such as China, Japan, and India remain dominated by national programmes, driven by regional and international geopolitics but are seeking to grow their commercial sectors. Emerging

countries on the other hand have seen a mix of national, commercial and academic initiatives emerge in parallel. They are keen for experienced space actors to help them develop their national space expertise and to use them as partners in future projects.

8. Space services are typically associated with earth observation, communications, and position, navigation & timing (PNT). These traditional services remain important and are used for a growing number of applications such as agriculture, fisheries monitoring, urban development monitoring, disaster monitoring and response, entertainment, internet services in remote locations, telemedicine, machine-to-machine communication for the internet of things, vehicle tracking, and traffic management. Indeed, the UK Space Agency estimates 80% of UK growth in the space sector will come from space applications. Looking forward, new services such as commercial space situational awareness, on-orbit servicing, debris removal services, space mining, space transport, and space mining are being proposed. One speaker mentioned an Australian project to use metals found in space debris as a source for ion propulsion, which could theoretically make space activities more sustainable in the future.

9. So called “New Space” companies have sought to break traditional commercial models in order to reduce the time and cost of satellites and launch services. This revolution has been spearheaded by a number of Silicon Valley entrepreneurs who sought to bring the ambition and speed of delivery experienced in the Information and Communication Technology (ICT) sector to the space sector. Ultimately, their vision is for the commercial sector to undertake missions that were traditionally the responsibility of governments whether EO, communications, space launch, human spaceflight.

Risks in the new environment

Space is becoming far more congested

10. There are currently around 1400 active satellites in space. Over the next 10 years, an additional 16,000 satellites could be launched. The majority are likely to be small satellites, some operating through mega-constellations comprised of hundreds or even thousands of satellites and operating a rapid refresh cycle of around 2-3 years. Operators of these mini-, micro- and nano-satellites can often be completely new to the space sector and this can increase the risk to all space operators for a number of reasons:

    - Smallsats are less likely to have onboard propulsion in order to save on space and weight, which increases their chances of collision as they cannot manoeuvre to avoid debris or de-orbit at the end of their useful life.
    - The satellites are harder to detect from the ground, which means other assets will find it harder to avoid them unless they are declared internationally.
    - Smallsats are moving to use commercial off-the-shelf electronics rather than space-rated components, which makes them more vulnerable to space weather.
    - Operators are not always aware of the need to de-conflict their use of spectrum with others.
    - Operators may not be aware of international legal regimes or established norms of behaviour.

Space is also becoming more dynamic

11. Satellites are increasingly manoeuvrable, in part to allow satellites in GEO to reach orbit and operate flexibly, and partly to avoid collisions and deorbit safely. But as congestion increases, de-confliction manoeuvres themselves may increase the likelihood of different conjunctions. The use of ion propulsion rather than traditional chemical propulsion means satellites will move more slowly over longer periods of time, which complicates the tracking of satellites as they manoeuvre in GEO and also lengthens the time it takes for a satellite to move from GTO to GEO, potentially exposing them for longer periods in crowded lower earth orbits. And even in ‘safe

orbits' things are not always simple: solar weather can flatten the orbit in GEO (bringing defunct satellites pushed into a graveyard orbit back down to GEO altitudes) or the drag profile of satellites operating in LEO can change depending on when their transponders point at the ground. Constant surveillance is therefore needed.

Registration problems

12. According to the UN Convention on Registration of Objects Launched into Outer Space, all space faring nations are obligated to register satellites with their national agencies and inform the United Nations. However, not every nation complies with this convention, and even those who do rarely disclose platforms used for national security. A number of participants argued that national security was no longer a valid excuse for not registering their satellites. Not only was it imperative for all nations to hold a common space situational awareness picture for safety reasons but because the availability of independent sources of detection means that by not declaring a national security asset, a state merely draws attention to it.

Space debris

13. Built up over the last 60 years, it has now reached worrying levels. The US currently tracks 22,000 objects (of at least 5cm3); this is expected to increase to something in the range of 200,000 to 700,000 objects when the new Space Fence, which will track objects as small as 1cm3, goes into service. It is likely that different solutions will be required for different orbits. The UN IADC committee produced guidelines in 2007 that recommended all satellites in LEO should deorbit within 25 years of being launched and all satellites in GEO should be moved into a graveyard orbit once they have finished their missions in order to avoid interfering with active satellites in GEO. Only 40% of satellites in LEO are currently built to comply with the IADC guidelines. There are some exceptions: satellites launched into very low earth orbit will naturally deorbit as a result of passive deceleration in the upper atmosphere. However, there is very little monitoring to ensure compliance with the guidelines, nor repercussions for those who fail to comply.

14. Residual propellant in retired space objects can also cause explosions, which creates additional debris and some space objects have nuclear material on board. There may therefore need to be mechanisms developed to "passivate" spacecraft and disused upper stages.

Space weapons

15. International tensions have prompted greater investment in space systems – particularly in Asia. During the Cold War, both the United States and the Soviet Union tested anti-satellite weapons but had largely stopped active development of those programs by the time the Wall had fallen. The successful Chinese ASAT test in 2007 prompted a renewed interest. The US subsequently destroyed a defunct weather satellite in 2008 and Russia has tested its Nudol direct ascent capability five times (three times resulting in an intercept). This is having a cascading effect. Indian defence officials, for example, are becoming increasingly vocal about the need for an Indian ASAT capability in order to deter China. However, given the debris cloud created in 2007, direct ascent weapon systems are largely seen to provide far too much collateral damage. Co-orbital capabilities complicate the adoption of on orbit servicing or debris removal technologies, as the same technology might be used for nefarious purposes.

Spectrum or radio frequency interference (RFI)

16. Both intentional and unintentional forms are increasingly problematic. States might not contemplate kinetic weapon systems because there is far too much risk of collateral damage and also of retaliation, whereas RFI is perceived to be temporary and reversible, so it sometimes is thought to be more usable. After a country has complained to the International Telecommunications Union (ITU), there are few other enforcement mechanisms, and the ITU cannot do more than ask the nation where the jamming is coming from to stop doing it. There are rarely any repercussions, even when the interference is deliberate and attributable. Finally, there is an increasing

competition for spectrum between ground based telecoms operators and space based services. Often the telecoms industry has a very well-developed lobbying machine and as spectrum can provide excellent revenues for the government, it is often tempting to sell off frequencies without understanding the consequences.

Electro-optic illumination is on the increase

17. There are hundreds and maybe even thousands of laser illuminations into space annually for calibration, ranging, communications and other civil applications. Military forces are also increasingly interested in adopting high energy laser systems for ranging and self-defence applications. A number of naval programmes are set to come online by 2019-2020 but there are also land-based and airborne programmes under development. In the meantime, experiments or exercises involving DEW have the potential to interfere with satellites as the lasers can propagate into space. There have also been instances of deliberate illumination of Earth Observation satellites. While laser ranging of cooperative targets in space is usually done in collaboration with the operator and the US DoD has a laser clearing house, there are currently no internationally recognised standards to deal with electro-optic illumination. It might be prudent therefore to consider measures to tackle EO-illumination as part of broader transparency and confidence-building measures.

Space situational awareness and space traffic management

"Current arrangements for space object tracking and collision avoidance are unlikely to meet the growing demands of a congested and increasingly civilian space environment"

18. Given the increasing congestion of certain space orbits and problems with space debris, current arrangements for space object tracking and collision avoidance are unlikely to meet the growing demands of a congested and increasingly civilian space environment.

19. Currently most registry data and deconfliction warnings come from the US Joint Space Operations Centre (JSpOC), which volunteers deconfliction warnings to both government and commercial operators. The open source information provided by the US JSpOC regarding each satellite is naturally limited by national security caveats. As a consequence, the catalogue released is incomplete (it does not feature any of the US national security satellites or those of allied nations) and up to a third of objects large enough to be tracked are not listed. Furthermore, the JSpOC is not always good at handling when satellites adjust their orbits, has produced false positives for potential conjunctions and can be prickly when others point out inaccuracies in the register.

20. As a consequence, other countries, including Russia and China, and commercial entities also have space tracking and SSA capabilities. Examples of civilian organisations include the Space Data Association (a group of 30 satellite operators collectively managing 613 satellites), ComSpOC who own a number of their own independent sensors and buy time on other capabilities around the world, universities such as Strathclyde University, University College London and University of Arizona, and the star gazers' website 'Heavens Above'. Not all of these can currently produce data of the quality that space operations centres might wish to use.

21. Given the rising numbers of commercial constellations, there have been discussions in the United States about delegating the civilian space situational awareness picture to the Federal Aviation Administration (FAA) and eventually looking to produce a space traffic management system. Expanding the role of the FAA rather than setting up an entirely independent body will also help manage the burgeoning US space launch community, who will have to coordinate and de-conflict with civilian air traffic during the first stage of launch.

22. Eventually, however, it will be imperative that the international community has a shared common SSA picture. This is particularly important as space tourism and other missions involving humans take off. Regardless of who provides the data, there is a requirement to manage the information passed to satellite operators and reduce the number of false alarms. China, for example, found that emerging nations starting out in

the space sector could be overwhelmed by the amount of data passed to them.

23. Direct engagement with satellite operators will also improve the SSA picture. Operators are able to provide more detailed information about the satellite, such as size, configuration, onboard fuel, which help produce a more accurate picture and can help Space Operations Centres provide more helpful information - excessive manoeuvring, for example, is highly undesirable as it can use up valuable onboard fuel. This will be important particularly with mega-constellations of near-identical satellites as it is not always easy to resolve their independent orbital trajectories.

Legal frameworks: problems and proposed changes

24. The existing international legal framework covering activities in space is based five legal treaties (and five principles):

    - Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (1967)
    - Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (1968)
    - Convention on International Liability for Damage Caused by Space Objects (1972)
    - Convention on registration of Objects Launched into Outer Space (1976)
    - Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (1984)

25. The Outer Space Treaty (OST) forms the basis of most space activity. However, of the 84 nations who are members of COPUOS, there are still a number who are not treaty members of OST. There are some who argue that the OST does not completely cover the full range of space activities today, particularly with regards to the commercialisation of space, guidance on how to manage debris, laws covering the use of on-orbit servicing, and laws looking at the management of near earth objects and space mining. The 1984 Moon Convention would cover some of these activities but has only a dozen signatories to date and is not generally considered to be part of the main body of space law.

26. Satellites are considered the property of the launching state. Article 1 of the Registration Convention clarifies that a “launching state” includes both the state that procures or launches a space object and the state from whose territory or facility the space object is launched. According to Article 8 of the Outer Space Treaty: ‘A State Party to the Treaty on whose registration an object launched into outer space is carried shall retain jurisdiction and control….’ But if that state no longer has control over their space asset, may others intervene in order to assure the continued safety of all space operators? It was suggested by some participants that the 2007 Nairobi International Convention on the Removal of Wrecks, written for the maritime domain, might be applied to the space sector.

27. Transfer of control: current space law assumes that the ‘launching state’ will have indefinite control over the satellite. However, today satellites are built in one state, launched by another, operated in a third, serviced potentially by a fourth, control may be transferred to a fifth, and the satellite may be de-orbited by a sixth. There should be liability apportioned to the relevant state and/or company at each of these stages and suitable procedures to transfer control.

28. In the event of a collision or an incident where damage is sustained by a satellite, liabilities in space between states lies in fault being proven. This is difficult enough in the case where a satellite sustains a collision or is attacked by another satellite as satellites rarely have onboard sense and avoid capabilities. However, it becomes even more problematic in incidents where the satellite sustains radio frequency interference or electro optic interference or a cyber attack.

29. What will space mining mean for space law? The US surprised the international community in September 2015 when it gave permission to US companies to undertake

asteroid mining. Legal experts at the conference stated that there was no explicit ban on such activities in existing international law so long as the State authorising the activity did not try to lay claim to the land or the celestial body on which it was mining as this was explicitly banned by article 2 of OST. Some nations have raised objections in international fora principally to stall US asteroid mining activities and allow for a more level playing field where a number of states may also engage in similar activities.

30. The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (1984) pretty comprehensively covers all potential areas of dispute but the lack of signatories makes it a weak instrument at present. The Agreement makes it clear that states retain liability for any activities conducted on other celestial bodies, that no state should put another state at risk through the engagement of such activities.

31. Article 11 is most pertinent to space mining, and states that "States Parties have the right to exploration and use of the Moon without discrimination of any kind, on the basis of equality and in accordance with international law and the terms of this Agreement"; and "States Parties to this Agreement hereby undertake to establish an international regime, including appropriate procedures, to govern the exploitation of the natural resources of the Moon as such exploitation is about to become feasible. This provision shall be implemented in accordance with article 18 of this Agreement".

32. However, at present such an international regime is not under consideration. Legal experts have suggested the right of USUFRUCT i.e. right to use and profit from resources but not to own land or interplanetary objects). A similar mechanism can be found through the 1982 UN convention on Law of the Sea and Commission on Limits of the Continental Shelf which allows for the rights to fish in international waters but does not give a nation the right to own international waters.

33. Finally, unlike other treaties, Outer Space Treaty does not allow for a review mechanism. So this year's 50th anniversary may be an opportunity to implement a regular review process, although a review may still be seen as a renegotiation.

"National governance and regulation needs to adapt in order to better reflect the new space environment"

National governance

34. While international law does need to change, the Liability Convention still places the responsibility for all activities squarely on the shoulders of State Parties to the Treaty. National governance and regulation therefore needs to adapt in order to better reflect the new space environment and indeed, in the absence of international rules, states can lead the way in developing sensible guidelines and best practice for all space faring nations. A good licensing regime should include:

    - International laws;
    - National policy and management of the state's international reputation;
    - National & international security requirements;
    - Insurance obligations;
    - Space debris guidelines (mitigating risk of debris created on launch, at least meeting 25 year rule regarding the de-orbiting of satellites and upper launch stages)
    - Technical assessment
    - Commercial assessment
    - Adequate financial assessment and corporate standing.

35. The UK's existing legislation is based around the 1986 Outer Space Act, which was written at a time with infrequent space activity and that predominantly driven by nation states. The UK has therefore set out to update this legal framework, operating from the principle that good regulation should provide an enabling framework for national innovation as well as help governments manage risk. Specifically, the following:

Policy recommendations

36. The conference produced policy recommendations focused on three key areas: transparency and confidence-building measures (TCBMs), legally binding vs voluntary measures, and government-industry collaboration.

TCBMs

37. How to make civil space traffic management more trustworthy?
    a. Open up the floor plate to representatives of multiple nations
    b. Value added processing of the data received from other sources
    c. Different (multinational, commercial) sources of data
    d. Make it international in character - build facilities in a neutral state

38. National Implementation of guidelines:
    a. 2013 recommendation of Group of Government Experts on Space TCBMs
    b. Debris Mitigation Guidelines
    c. COPUOS Long Term Sustainability guidelines

39. Encourage all space-faring states to sign the Outer Space treaty, and also, propose an iterative review process for OST

40. Enhance the capabilities of emerging space actors (to help new space actors meet their obligations), perhaps through funding a multinational fund?

41. Procedures for dealing with radio frequency interference

Legal and voluntary measures

42. Make objects trackable

43. Passive measures eg reflective surfaces

44. Active measures eg GPS chips, Interrogation Friend or Foe (IFF), Aeronautical Information Service (AIS)

45. Share more relevant data

46. Implement existing international law including the notification of space objects

47. Minimum technical standards for satellites operating in certain congested orbits before licensing their operations to ensure their own safety and that others in the orbit

48. Transfer of ownership

Government-industry collaboration

49. Develop understanding of what is the responsibility of governments and what is the responsibility of the commercial organisation.

50. Need to build context and establish a foundational obligation to have a base knowledge of knowledge

51. Common Situational Awareness

52. Easiest through the establishment of stakeholder committees and trade associations.

53. Understanding of national space ecosystem to operate effectively in multinational bodies

54. Government should open the door and industry should find it.

55. It was felt that the voluntary measures were the most feasible within the next 5 years and that better government/industry collaboration was also achievable. Although all the TCBM proposed were broadly sensible, there was scepticism that these might be achievable given the glacial pace of progress in international fora.

Summary

The space community is facing a real renaissance period. The next few years in particular will see the pace of change increase dramatically. There is a collective excitement about

the opportunities that these next few years may offer. There is also a recognition that if the rules of the road can be adjusted and properly implemented that there will be tremendous advances both for life on Earth and in terms of expanding human activities into the Solar System.

However, the risks are also real. There will be global consequences if the space environment becomes polluted through deliberate or negligent behaviour. Improved space situational awareness will be essential in order to safely increase the global space activity. Space Traffic Management may also become necessary in due course. There is therefore a requirement for all space-faring state to sign and implement existing treaties and (if it proves too difficult to revise or add to existing laws) for transparency and confidence-building measures to be adopted so that new activities such as on on-orbit servicing, space debris removal, and space mining can be conducted responsibly. States will need to actively engage with the commercial sector in order to both help facilitate and regulate their activities.

All space actors can encourage responsible behaviour by leading by example through the adoption of technical solutions or information sharing constructs.

Existing geopolitical tensions and national security activities can both drive an increase in space activities and increase the risks. Military forces on Earth abide by the Laws of Armed Conflict (LOAC) and International Humanitarian Law (IHL) which seek to minimise the effects of conflict on civilians. Efforts to adapt LOAC and IHL to the space environment are highly laudable and should be both strengthened and implemented when complete.

Finally, cyber security was barely mentioned during the conference but cyber and space are intrinsically linked. Cyber attackers can have a range of motivations but competitive advantage and financial gain tend to top the list. There is good reason therefore to assume that the incidence of cyber attacks on space companies and space infrastructure will increase. It was proposed that cyber and space may be the topic for the next Wilton Park space security conference.

Elizabeth Quintana
Wilton Park | June 2017