Conference on Disarmament

8 August 2019

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Note verbal dated 27 June 2019 from the Permanent Mission of the United Kingdom of Great Britain and Northern Ireland addressed to the Office for Disarmament Affairs, in its capacity as the secretariat of the Conference on Disarmament, transmitting the report of a Wilton Park conference held on 31 March to 2 April 2019 entitled "Operating in space: towards developing protocols on the norms of behaviour".

The Permanent Mission of the United Kingdom of Great Britain and Northern Ireland presents its compliments to the Office for Disarmament Affairs, in its capacity as the secretariat of the Conference on Disarmament, and has the honour to circulate the report of a Wilton Park conference held on 31 March to 2 April 2019 entitled "Operating in space: towards developing protocols on the norms of behaviour".

The Permanent Mission of the United Kingdom of Great Britain and Northern Ireland requests that the attached report be registered and circulated as an official document of the Conference on Disarmament.

The Permanent Mission of the United Kingdom of Great Britain and Northern Ireland avails itself of this opportunity to renew to the Office for Disarmament Affairs, in its capacity as the secretariat of the Conference on Disarmament, the assurances of its highest consideration.

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Operating in space: towards developing protocols on the norms of behaviour

Report

Sunday 31 March – Tuesday 2 April 2019 | Wilton Park 1680 in association with the United Kingdom Space Agency and the Ministry of Defence

I. Executive summary

A. Conference rationale

1. In March 2019 Wilton Park convened a two-day conference on operating in space — sponsored by the British government — for an international group of experts from the policy, academic, non-governmental and private sector space communities. Attendees met in a neutral environment designed to encourage an open and constructive exchange, with the objective of exploring whether norms of behaviour could be expressed as protocols and the possible language that could be used to draft such protocols.

B. Representation

2. A total of 45 representatives from 13 nations (Australia, Brazil, Canada, France, Germany, India, Japan, New Zealand, Russia, Switzerland, Turkey, the United Kingdom and the United States) as well as representatives from the European Union, the United Nations, industry and academia took part in the conference.

C. Discussion focus

i. Launch.

ii. Debris mitigation and management.

iii. Space situational awareness.

iv. In-orbit and proximity operations.

D. Key questions considered

i. Could nations be encouraged to share information more easily and inform others of problems?

ii. Could sovereign and commercial operators work together more effectively?

iii. Can data be shared to build a better picture of activity in space?

E. Key take-aways

i. Space is rapidly commercializing and democratizing and the increasing number of government and commercial operators in the domain is making cooperation and communication more important than ever.

ii. Most problems relating to the use of space require global solutions as well as responsible state and private sector actors who fully understand the benefits of and challenges to operating safely and responsibly in space.

iii. Global solutions are not possible unless every space actor works together to share data, communicate before making manoeuvres, design their missions and space assets to mitigate debris, agree to uniform standards for launches and establish ground rules before undertaking new and innovative operations.

F. Practical and achievable next steps for the international space community

i. The international community should create a 'code of conduct' wherein states notify other states of planned launches quickly but explain what those launches will do and the effects they will have.

ii. National regulators should require operators to de-orbit inactive space assets within five years of end-of-life or as soon as they are unresponsive including mega constellations at LEO.

iii. National regulators should no longer issue licenses to operators who do not have thorough and robust collision avoidance, data sharing and debris mitigation strategies.

iv. Governmental, commercial and academic operators should start collaborating and data sharing through an internationally verified space situational awareness system.

v. Entities wishing to conduct proximity operations should engage in a shared communications system to unsure any problems can be quickly and easily communicated and resolved and trust maintained.

II. Introduction

A. Reliance on space

3. The world is ever more reliant on space assets for its prosperity and security and nations need the data and knowledge that flows from space, an environment that is increasingly contested and congested. This does not bode well for the future of space: congestion means more debris, more potential for collisions and fewer sustainable orbits. More congestion also increases the likelihood of behaviour by one actor that another could perceive as hostile, with the potential for escalating responses, leading to an overall less secure space domain.

B. Current practices

4. In order to preserve the freedom to operate in space and to promote international cooperation and collaboration, spacefaring nations and their companies need to first understand what the current practices in space are and then develop norms of behaviour that reflect how operators are currently acting in space and should continue to act in future.

C. Growth in launches and new actors

5. Of particular note is the rapid growth of the launch industry in recent years, with an ever-growing number of new providers offering smaller and cheaper options. This growth has allowed more and more countries and companies to start operating in space: however, it has also raised a number of new issues, many of which are regulatory. Existing space actors have identified the need to ensure that this increasing number of launches meets minimal safety standards and questioned how much information operators should be required to provide about their launches. Furthermore, launches create debris and it is therefore important to act to minimise this from the start by setting debris mitigation requirements. There is currently no international regulatory body overseeing launches or coordination on what constitutes "launch best practice".

6. Until now only a select few nation-states and private actors could afford the costs and risks of operating in space. Satellites were large and expensive undertakings and launches were only possible through a handful of providers and at a handful of locations. Through recent innovations such as small satellites and an explosion in the number of small launch providers, the cost of entry has reduced dramatically and space is rapidly democratising. Countries no longer need to build their own infrastructure but instead can pool resources and share in the benefits of space. Private actors such as start-ups and universities can send previously cost-prohibitive projects and experiments into orbit. Space has long served a vital role in providing key services on the ground in areas such as GPS/GNSS, remote sensing, telecommunications and weather monitoring but the vast potential of this domain is yet unrealized.

D. Moving beyond the binary discussion of militarisation and commercialisation

7. Much of the multilateral discussion presently focuses on disarmament or the utilisation of space for development and peaceful purposes but grey areas exist between the two where the actions of spacefaring nations and their private sector companies can either serve to build trust or generate hostility.

III. Framing issues

A. Long term sustainability

8. With the increasing democratization of space comes a responsibility and need to keep space sustainable. More players in the game naturally leads to more launches to coordinate, more objects to track, more debris to avoid and more critical systems at risk. Debris, for example, can be perilous to satellites and easily created through poor mission design or negligent use of space assets. As the number of launches increases, so too will the amount of debris as well as the likelihood of a catastrophic collision. Achieving sustainability will require a global effort and can be realized through efforts such as cataloguing space objects, mitigating debris creation and sharing relevant operational data. A sustainable environment means that current actors can continue to operate with minimal disruption, while new space-faring nations and companies will be assured that the domain will remain accessible in the future. As operating norms are established, it is important to ensure that the rules of the game will be fair and allow new actors the opportunity to grow.

B. Security

9. Alongside sustainability, actors also need to maintain a safe and secure operating environment to maximize the potential benefits of space. While debris poses a significant risk to operations, so too would the aggressive use of technologies. It is in the interests of all nations to ensure that nation-states feel secure and trust the actions of others in space.

C. Debris

10. Debris mitigation and management are far from the most headline-grabbing topics, but they are likely the most important and challenging to coordinate. Completely eliminating debris is not possible, but actors can work to limit it by making small satellites more trackable and through setting mitigation standards. Individual countries need to contribute by setting their own rules, but many potential solutions require international coordination to implement. While the best method for eliminating debris is undoubtedly preventing its creation in the first place, existing debris can still be taken care of through active debris removal (ADR). However, ADR is tricky and any operator needs to consider whether they might be interfering with someone else’s property, how to actually move the ADR asset next to an unpredictably moving piece of debris and to find economic incentives

for removal in the first place. Since no-one has yet successfully completed an ADR mission, the first actor will set the standard. Consideration must also be extended to on-orbit servicing (OOS), another form of in-orbit operations which could include satellite refuelling or repair, although the commercial appetite for these services is unproven.

D. Space situational awareness (SSA)

11. For space actors to operate confidently, avoid miscalculations and ensure that space remains secure and sustainable, they need a complete picture of the operating environment. This picture allows them to understand where space objects are, create on-orbit risk models and conduct manoeuvres to avoid collisions. Sharing space object data is the necessary foundation. Effective data come from a variety of sources and allow for multiple observations which can then be compared through multiple, diverse models. Currently, the community is sharing opinions but not the underlying evidence. Satellite operators need a complete picture of the environment around them to make decisions confidently. This picture provided by SSA tells them where other satellites and space debris are and informs their decisions on how to avoid them.

E. The importance of cross-cultural communication

12. Transparency in data sharing, alongside improved confidence in the accuracy of those data, goes a long way to building trust. Similarly, communications between operators can demystify the intent of a nearby satellite and allows operators to trust their neighbours when making manoeuvres. Even perfect data cannot show intent and when operators do not communicate, simple misunderstandings can potentially lead to serious problems. It is likewise important to practice cultural understanding when communicating with other operators. Satellites, after all, are controlled by humans and understanding another actor's motivations can allow operators to avoid accidents before they happen.

F. Risks and attribution

13. In the end, though, space is an inherently dangerous operating environment and operators must deal with terrestrially based, accidental and environmental risks. Some of these risks can be minimized through design approaches such as radiation hardening or adding extra protection to electrical systems. Another potential avenue is through insurance, which has long played a role in launch services. Ultimately, collisions will occur and the need to settle disputes will arise. However, it is currently very difficult to provide the body of evidence necessary to establish fault for in-orbit collisions and a claim for damages for an in-orbit collision has yet to be filed.

IV. Challenges to be addressed

A. The need for regulation and international cooperation

14. Space debris is a classic tragedy of the commons issue: orbits are a shared resource but without coordination, individual actors may degrade them until their utility is drastically minimized or even eliminated completely. Space is on the cusp of a democratizing revolution, but international and national regulations are still catching up with operational capabilities. There is little doubt, however, that some form of regulation is necessary and many countries have recently begun to implement national space regulations with an eye toward the future. The broad global concern is whether these national efforts may promote a 'race to the bottom', wherein a lenient regime would attract business but promote lax sustainability standards. Similarly, many countries have space development agencies tasked with growing a domestic space industry. Encouraging responsible operational behaviour and promoting economic growth are goals in tension with one another and the international

space industry is still in the process of determining where to strike the balance between these two aims.

B. Commercial and technical drivers

15. Addressing these concerns has proven difficult in the traditional inter-governmental forums. Space is rapidly commercialising and multilateral settings are not built to address the concerns of commercial entities. For now, all that industry can do is hope that nations will keep their concerns in mind. Furthermore, the technical and political sides of the debate have remained hitherto separate. The groundswell of cooperation is likely to begin between scientists and technical experts. Ultimately, political decision-makers need to be adequately equipped to understand and address these issues.

C. Towards norms of behaviour

16. With this climate in mind, the conference considered whether establishing protocols on norms of behaviour could be useful to keep space sustainable and safe for the future. Norms cannot be dictated but must rather be based upon observable practice. Since space is already a well-established operational domain, practices currently exist but are yet to be systematically observed and codified. The conference participants discussed what practices currently exist, which behaviours the community would like to see become commonplace in the future and produced recommendations on how the space community may best work towards creating protocols that ensure that they do so. In order to create norms of behaviour in space, we need to understand what is actually happening in Earth orbit, to consider what constitutes normal behaviour. If we do not know constitutes normal behaviour, then we do not know what constitutes unusual behaviour. And if we do not know what constitutes unusual behaviour, then we cannot respond to problems as they unfold in order to keep the space domain sustainable, safe, and secure.

17. The conference considered four focus areas:

i. Launch.

ii. Debris mitigation and management.

iii. Space situational awareness.

iv. In-orbit operations.

V. Focus area: launch

A. Considerations

18. Launch services have seen rapid growth in recent years with a plethora of new small launch providers entering the fray. With growth in launch capacity around the world comes a host of new issues that need to be addressed. Liability for accidents is one such issue: under the current international legal framework, launching states are liable for accidents caused by private parties. The process of launch takes a space craft to its final orbit. A ‘launching state’ has been very broadly defined, to the point where multiple states may simultaneously meet this definition and are all joint and severally liable. The broad definition of ‘launching state’ increases uncertainty about which state should be in charge of a launch and may make states reluctant to register and promote commercial launches in future. Launches necessarily create debris and therefore debris mitigation guidelines should be applied to launch as well as to in-orbit operations. In fact, spent upper stages represent a major concern due to the potentially dangerous unused fuel contained in them. Therefore, launch providers should take on some responsibility to prevent the creation and danger of debris by coordinating with air traffic management and SSA providers to prevent conjunctive events.

B. Questions

19. The conference participants highlighted the following pressing questions concerning launch activities:

i. What kind of launch activities are acceptable and should be approved by national regulatory bodies and which are not and should be rejected?

ii. Are ″frivolous″ payloads acceptable or should there be requirements for what kind of payloads should be approved?

iii. Do the current controls regarding the security of technology in launch vehicles meet the required standards?

iv. What information should operators give to launch providers about the payload, how transparent should launch practices be and how far in advance should the data be shared?

v. How should sub-orbital activities be regulated and how can launch providers better coordinate with air traffic management and how can jurisdiction shopping be avoided when regulations are imposed?

vi. What are nations required to do to in order to be in compliance with the Registration Convention?

vii. How should reusable launch vehicles be regulated and will space tourism launches be handled differently from other launches?

viii. How can regulators best accommodate new space entrants unfamiliar with registration requirements?

ix. Which party is liable for a faulty conjunctive analysis, the operator or the analyst and should liability be separated from registration status?

x. Should there be a standard for informing mariners and airmen about the potential of orbital debris associated with launch?

C. Recommendations

20. The conference participants made the following recommendations regarding norms of launch behaviour:

i. Establish what constitutes acceptable and unacceptable launch behaviour.

ii. Create an international regulatory body for space launch similar to the International Civil Aviation Organization (ICAO) that establishes global regulatory best practices.

iii. Consider an international framework that is differentiated by orbit to reflect the operational characteristics and debris risks in inserting a satellite to each.

iv. Create a consistent international registration policy for rapid registration through a code of conduct which could later be codified through a treaty process.

v. Separate commercial launches from those with military purposes.

vi. Ensure that any new international launch rules address re-entry as well as launch.

vii. Ensure that international launch rules address commercial launches, especially commercial human spaceflight.

viii. Develop clearer rules for liability for multi-jurisdictional launches.

ix. Improve communications between launch providers and space domain awareness providers, particularly to prevent collisions during the orbital insertion phase.

x. Push the international community to come to an agreement on whether spent upper stages need to be registered.

VI. Focus area: debris mitigation and management

A. Considerations

21. The problem of space debris needs to be addressed on a global scale and requires coordination between government and commercial space actors. The most obvious but also effective solution is to prevent debris from being created in the first place by implementing debris mitigation requirements. Controlling how much is created and where will allow space actors to be aware of its presence. Another measure lies in encouraging satellite manufacturers to make their products more easily trackable. All satellites become debris at the end of their lives, so a satellite that can be easily tracked becomes a more manageable risk. Debris mitigation is combating an environmental concern and as such lessons can be drawn from climate change mitigation efforts. One potential solution could be to impose fees akin to a 'carbon credit' to help governments pay for debris removal. Another possibility is implementing a 'congestion charge' similar to London's road traffic charging scheme wherein operators are required to pay a fee to access crowded orbits. The obvious question is to what degree the space community is willing to potentially hinder economic growth in the name of safety. The issue of debris is extremely challenging but invites a wide range of potential solutions and outside-of-the-box thinking.

B. Questions

22. The conference participants highlighted the following pressing questions concerning debris mitigation and management:

i. What constitutes a precise definition of debris?

ii. What is the maximum allowable risk during in-orbit convergence?

iii. When will debris become such a pressing issue that the monetary cost of debris removal will no longer be an issue?

iv. What happens if debris proliferation is not addressed?

v. How could mitigation guidelines be implemented? Through industry standards, regulation and/or multilateral treaties?

vi. How can actors be incentivised to mitigate debris creation?

vii. Is ADR different for mega constellations and should ADR be part of every launch?

viii. How can industry raise awareness about the need for debris mitigation and the creation of mitigation standards?

ix. Should there be repercussions for not de-orbiting a dead satellite? What form would these repercussions take? Which body would enforce the rules?

x. How can industry promote participation in creating debris mitigation guidelines?

C. Recommendations

23. The conference participants made the following recommendations regarding norms of debris mitigation and management behaviour:

i. Promote the UNCOPUOUS Long Term Sustainability guidelines to national stakeholders to achieve widespread consensus.

ii. Create an appropriate structure to cover all aspects of debris: prevention, tracking, active debris removal (ADR) and life extension.

iii. Implement a mature risk management approach.

iv. Prohibit intentional debris creation and create internationally agreed-upon standards of debris mitigation.

v. Require operators to dispose of assets within five years of end-of-life and encourage national space agencies to undertake ADR for their own debris.

vi. Create an internationally agreed-upon approach for removing orphaned debris and define the legal framework for non-consensual debris removal.

vii. Stop issuing licenses to operators who do not have avoidance and debris mitigation strategies.

viii. Establish effective voluntary OOS and ADR guidelines through international forums.

ix. Ensure commercial operators take responsibility for preventing debris associated with their satellites.

x. Establish an international fund for ADR of space debris.

VII. Focus area: space situational awareness

A. Considerations

24. Establishing norms of behaviour for SSA means promoting the consistent exchange of data and improving their quality. Currently, raw data are not actually shared but rather put into a giant pool from which they are extracted as required. The amount of data will only dramatically increase in coming years as more advanced systems with the capability to track smaller and smaller objects come online. However, more data is not necessarily better: it is more important to ensure that the data is independently sourced, verifiable and accurate. It is also important to remember that data do not come for free and operators need to see the benefit of paying for SSA data from outside their own analytics. In the end, decisions are made by human beings. It is therefore vital that operators improve communications with one another to minimise misunderstandings and test the quality of the data being relied upon. Comparing observations opens a candid conversation whereby flaws can be identified, intentions deduced to prevent tense situations and the overall capacity of systems improved. The greatest roadblock to improving SSA is the reluctance to share data. Finding ways to incentivise and facilitate this sharing will go a long way to ensuring sustainability and safety in space.

B. Questions

25. The conference participants highlighted the following pressing questions concerning SSA:

i. What constitutes a precise definition of ″space situational awareness″?

ii. How can actors be incentivized to share data, algorithms and tools and in what ways can environmental and debris population modelling be improved?

iii. What are the commercial benefits of contributing to SSA besides risk mitigation?

iv. How can insurance premiums be used to incentivise best practices?

v. In what ways can data from decentralized information sources be better combined and how should SSA data be shared between commercial and government entities?

vi. How will industry react when a flood of new information comes online with Space Fence?

vii. How should industry better communicate the need for better SSA to the public and politicians?

viii. What mechanisms should be developed to allow actors to improve communications with one another?

ix. Who should take the lead in establishing SSA sharing frameworks? Governments or industry?

x. Why do governments keep satellite positions confidential when they can be so easily tracked by anyone?

C. Recommendations

26. The conference participants made the following recommendations to better establish norms of SSA behaviour:

i. Fully integrate national and international governmental, commercial and academic SSA efforts and promote wider participation and reduce duplication of effort.

ii. Improve the visibility of SSA in the public domain and develop a strategy for communicating it as a global public good.

iii. Develop a precise, reliable and accurate common operating picture for space based on SSA encompassing LEO, MEO and GEO.

iv. Develop mechanisms and standards for sharing data on space events.

v. Tie insurance premiums into the future development of SSA.

vi. Incorporate space meteorology into SSA models.

vii. Remain mindful of the classified domain but adopt a commonsense attitude to satellite location tracking.

viii. Encourage the use of transponders on satellites akin to the International Maritime Organisation's approaches to ship identification standards.

ix. Explore the use of Artificial Intelligence technologies in spacecraft collision avoidance.

x. Create incentives for leading governments to take the first steps towards developing international SSA.

VIII. Focus area: in-orbit and proximity operations

A. Considerations

27. In-orbit and proximity operations include commercial and state activities where two spacecraft are close to each other. Where one object approaches another it can be a cause for concern for operators. The development of on-orbit servicing (OOS) means that spacecraft will increasingly be in close proximity to each other. Also, states are operating satellites that approach others. ADR operators need to ensure that they are not interfering with another space actor's property, which can be challenging without a strong SSA system. ADR can be a high-risk undertaking since many pieces of debris are old and may still contain fuel, meaning that damaging a tank during removal may lead to an explosion. Also, while rendezvous with a controlled object is routinely accomplished, rendezvous with an uncontrolled object is an entirely different and much more difficult prospect. On-orbit servicing raises its own set of issues and can take the form of refuelling or repair and could be used to extend the operational life of a satellite. However, it is not yet certain whether refuelling or repairing a satellite will be commercially viable. As satellites become more and more advanced, operators may find it much more beneficial to simply replace the satellite with a new platform rather than extend the life of an existing satellite. Furthermore, LEO and GEO present distinct challenges for OOS, something that efforts to establish guidelines must take into consideration.

B. Questions

28. The conference participants highlighted the following pressing questions concerning in-orbit operations:

i. What form should ADR and OOS standards take? Should they be driven by legislation or industry standards?

ii. How can efforts to establish ADR and OOS guidelines be better coordinated?

iii. How should guidelines differ based upon the type of OOS or ADR mission?

iv. What will the appropriate international forums be? UNCOPUOUS? ISO?

v. How should dual-use capabilities be addressed through standards? Is it even possible to differentiate between military and civil applications?

vi. How do states communicate proximity operations to ensure others do not feel threatened?

vii. Where should the line be drawn between OOS servicing to what constitutes a use of force?

viii. How much information will be required from proximity operations and how much SSA data will operators be required to provide?

ix. Defining 'too close' is not useful so how do we have better communication of intent?

x. How can operational progress be communicated?

C. Recommendations

29. The conference participants made the following recommendations to regarding norms of behaviour:

i. Develop better international communications systems and practices including a register of contacts.

ii. Hold more intra- and inter-government dialogues and industry roundtables specifically on the issue of in-orbit operations.

iii. Encourage the pre-notification of manoeuvres by the actor to the operator of the approached vehicle.

iv. Encourage the notification of operations through the licensing nation and enhance transparency and predictability through the sharing of flight plans and 'keep out' zones.

v. Establish mechanisms to recognise the difference between state and commercial operations and so facilitate the justification of an OOS industry.

vi. Explore the possibility with industry of a standardised docking plate for space vehicles.

vii. Understand the impact of satellite docking on liability.

viii. Promulgate knowledge of existing practices as a necessary step towards further developing a common understanding including reporting of accidents and emergencies.

ix. Work to internationalise the issue and ensure that operational concerns become shared globally.

x. Develop and implement simple actions to enable and facilitate servicing such as more use of reflective surfaces on satellites.

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