The Promoting Space Sustainability Project:

awareness-raising and
capacity-building
related to the implementation
of the LTS Guidelines

Event #2
Summary Report

Space Agency Operators

February 25, 2021

The Promoting Space Sustainability Project: awareness-raising and capacity-building related to the implementation of the LTS Guidelines

Global investment in and dependency on space activities are increasing rapidly. Such trends underline the need to ensure space activities are sustainable over the long-term. As the United Nations' dedicated space entity, the Office for Outer Space Affairs of the United Nations Secretariat (UNOOSA) sits at the crossroads of the global space community and is well placed to bring together both private and public stakeholders on the subject. The Promoting Space Sustainability Project: awareness-raising and capacity-building related to the implementation of the LTS Guidelines seeks to raise global awareness of the importance of space sustainability and to foster related capacity-building services for emerging space-faring nations.

The Project is made possible thanks to the generous support of the United Kingdom and is delivered in the context of the landmark Guidelines for the Long-term Sustainability Outer Space Activities of the Committee on the Peaceful Uses of Outer Space (LTS Guidelines), whose adoption by the Committee in 2019 was welcomed with appreciation by the United Nations General Assembly.

The Virtual Event Series

In its first phase, the Project arranged a series of virtual events, aimed at facilitating peer-to-peer dialogue and an exchange of experiences implementing the Guidelines for the Long-term Sustainability Outer Space Activities of the Committee. Split across two sessions, each event focused on a particular sector of the global space community. Participants shared their experiences and examples of sustainable space activities. The first event focused on the commercial space sector, the second on space agency operators, and the third event on national regulators and policymakers. The events provided a platform to share operational space sustainability case studies outlining actions taken to implement the Guidelines for the Long-term Sustainability Outer Space Activities of the Committee, as well as lessons learned. The case studies and presentation slides submitted in connection with the events are made publicly available on UNOOSA's website, further supporting awareness-raising and related capacity-building on this critical topic for the global space sector.

UNITED NATIONS
Office for Outer Space Affairs

UK SPACE AGENCY

The cover picture of the Summary Report represents Earth viewed from the lunar lander ascent stage of the Apollo 11 Mission in 1969. Credit: NASA

Event #2
Space Agency Operators

The second event of the series introduced the experiences of space agency operators. Eight representatives of space agencies were invited to illustrate examples of their sustainable space practices. Such examples were mapped into the context of relevant areas covered by the Guidelines for the Long-term Sustainability Outer Space Activities of the Committee. Each session ended with an open, informal Question and Answer period focusing on the case studies.

Speakers for this event included:

- **Mr. Khaled Al Hashmi,** Director at the UAE National Space Science and Technology Center
- **Mr. Marius-Ioan Piso,** CEO at the Romanian Space Agency (ROSA)
- **Ms. Francesca Letizia,** Space Debris Engineer at the European Space Agency (ESA)
- **Mr. Sittiporn Channumsin,** Chief of Astrodynamics Research Laboratory at the Geo-Informatics and Space Technology Development Agency (GISTDA, Thailand
- **Ms. Lauri K. Newman,** Conjunction Assessment Manager at NASA
- **Ms. Francisca Parra Rojas,** Officer at the Air Force of Chile
- **Mr. Jacob Geer,** Head of Space Surveillance and Tracking at UK Space Agency
- **Mr. Valanathan Munsami,** CEO, South African National Space Agency (SANSA)

Opening remarks

The event was opened with remarks by **Ms. Simonetta Di Pippo,** Director of the United Nations Office for Outer Space Affairs and **Ms. Sarah Boyall**, Director of Regulation at the UK Space Agency.

Morning Session

1. **Mr. Khaled Al Hashmi,** Director at the UAE National Space Science and Technology Center (NSSTC)

Mr. Al Hashmi began his intervention by explaining that The UAE National Space Science and Technology Center (NSSTC) was established jointly by the United Arab Emirates University (UAEU), the UAE Space Agency (UAESA) and the Telecommunications Regulatory Authority in 2020. The objectives of NSSTC are to strengthen R&D activities related to space science and technology, to engage with the youth, and to contribute to the development of the UAE's space sector. NSSTC has 6 main activities as a consequence of the emerging technologies trends today: designing and building satellites; space propulsion; Earth and Planetary Science; on-board real time systems; space communications and precise positioning; and space payloads.

Mr. Al-Hashmi also emphasized within the topic of promoting sustainability on Earth through space applications, that it was with the help of the UAE Space Agency and NSSTC that medium and high-resolution land cover land use remote satellite sensing capabilities were set up in the Middle East and North Africa (MENA) region, in addition to the establishment of a public hub of an Earth observation land cover land use Earth observation Platform in the UAE.

The Director of NSSTC indicated key paragraphs related to the Guidelines for the Long-term Sustainability Outer Space Activities of the Committee as well. The pivotal role of international cooperation, and also **Guideline C.1** Promote and facilitate international cooperation in support of the long-term sustainability of outer space activities; **Guideline C.2** Share experience related to the long-term sustainability of outer space activities and develop new procedures, as appropriate, for information exchange; and **Guideline C.3** Promote and support capacity-building were emphasized as Space Situational Awareness (SSA) and Stace Traffic Management (STM) capabilities have been built through international collaborations in the UAE. Such international partnerships of the United Arab Emirates include one with the University of Texas joint work on the Computational Astronautics group, or the cooperation in Curtin University's Radio-Array group allowing UAE to contribute in global SSA and STM applications.

Further Guidelines for the Long-term Sustainability Outer Space Activities of the Committee referred by Mr. Al-Hashmi were Guidelines **D.1,** Promote and support research into and the development of ways to support sustainable exploration and use of outer space, **D.2,** Investigate and consider new measures to manage the space debris population in the long-term; **C.3,** Promote and support capacity-building; and **C.4**, Raise awareness of space activities with respect to scientific and technical research and

development mostly on the subjects of SSA and STM and satellite remote sensing. Such related activities of the UAE are in the initial process and also connected to a new Master of Science programme at the UAE University and NSSTC where more and more students entering the space applications field with scholarship possibilities. The UAE SA has also announced its so-called Arab Pioneer Programme, which gives the possibility to fund great talents in the UAE to take part in space research activities conducted by NSSTC under the supervision of designated faculties and senior researchers in the Center.

Mr. Al Hashmi's presentation in the event recording starts here.

2. **Mr. Marius-Ioan Piso,** CEO at the Romanian Space Agency (ROSA)

The Romanian Space Agency (ROSA) was established in 1995 with the objective to manage Romania's space programme and to represent the country in bilateral and multilateral fora. ROSA also provides delegation to the Committee on the Peaceful Uses of Outer Space (COUPOS), to the European Space Agency (ESA), and to the EU space programmes. Since 2018, ROSA have followed its '3S Strategy', which consists of Science, Services and Security activities.

The Head of the Romanian Space Agency also informed the audience in his presentation, in connection with **Guideline A.1,** Adopt, revise and amend, as necessary, national regulatory frameworks for outer space activities, and **Guideline A.2,** Consider a number of elements when developing, revising or amending, as necessary, national regulatory frameworks for outer space activities, that Romania is currently in the process of the creation of the country's national space law in which compliance with international space law instruments and long-term sustainability are primary factors.

Safety of space operations was also addressed by Mr. Piso, stating that ROSA has built its SSA and STM Space Operation Center, called Operational Space Surveillance and Tracking Centre - 'COSST' (related to **Guideline B.1,** Provide updated contact information and share information on space objects and orbital events; **Guideline B.2,** Improve accuracy of orbital data on space objects and enhance the practice and utility of sharing orbital information on space objects; **Guideline B.3,** Promote the collection, sharing and dissemination of space debris monitoring information; and **Guideline B.9,** Take measures to address risks associated with the uncontrolled re-entry of space objects**)**. COSST was built and operated by ROSA, and it is supported by the European Union Space Surveillance and Tracking (EU SST) Consortium and the ESA SSA Programme (including SST, space weather, and near-Earth object projects and missions). According to Mr. Piso, the Centre has both optical and radar capabilities to track space objects (as well as their re-entry and fragmentation) of 1 cm up until 1000 km altitude.

Besides its STM and SSA applications, Romania is currently in the process of building its Space Weather Data Centre, also ROSA participates in ESA's Space Weather missions, which activities are linked with Guideline **B.6** Share operational space weather data and forecasts and **B.7,** Develop space weather models and tools and collect established practices on the mitigation of space weather effects.

As lessons learned in relation to the Guidelines for the Long-term Sustainability Outer Space Activities of the Committee and ROSA's space activities, the Chief explained, national coordination and the creation of an inter-agency structure are inevitable to get the best use of space applications. Finally, Mr. Piso suggested to his audience that besides understanding all potential space activities that a country might pursue, it could be an ideal option to select among the given opportunities as a national space agency and address those space activities as national specificities (or 'niches') that might be technical, geographical, etc. functions and those should be in the center of a nation's space programme. Once you find your niche, Mr. Piso added, then you can start building capacity, centres, and competence.

Mr. Piso's presentation in the event recording starts here.

3. **Ms. Francesca Letizia,** Space Debris Engineer at the European Space Agency (ESA)

In her presentation, Ms. Letizia introduced the European Space Agency's (ESA) collision avoidance activities and linked them to the United Nations Long-term Sustainability Guidelines. First, the space debris expert explained why there is a need for collision avoidance services. On the one hand, mission operators willing to avoid the occurrence that their mission are prematurely terminated due to an impact with a piece of debris. On the other hand, thanks to debris collision avoidance, engineers are able to prevent occasions where large fragmentation events occur creating new objects in the debris environment. For the latter case, the space engineer brought up a famous example from 2009, when Cosmos and Iridium space crafts collided, creating 3294 new trackable space objects in the near-Earth environment. By now, Ms. Letizia asserted, collision avoidance gets more and more attention and even also a new International Organization for Standardization (ISO) standard and the Guidelines for the Long-term Sustainability Outer Space Activities of the Committee cover the subject.

Performing collision avoidance at ESA - as the space debris engineer explained - means mainly taking care of 15 current ESA missions, operating in low Earth orbit (LEO). Throughout her presentation, Ms. Letizia illustrated the change of space debris density in LEO, highlighting that some ESA mission satellites (such as Sentinel 2A/B of Copernicus) are operating very close to the highest debris density rate.

The process of collision avoidance at ESA was introduced next by Ms. Letizia. Accordingly, the process has two main data sources, the Space Surveillance Network (or the SSA data providers), and ESA's flight dynamics teams that mostly gives data on the trajectories of satellites and the maneuvers that they are planning to perform. Data given by SSA data providers are received in a form of conjunction data messages (CDMs), which is a standard format, according to the **Guideline B.2,** Improve accuracy of orbital data on space objects and enhance the practice and utility of sharing orbital information on space objects. As Ms. Letizia explained the CDMs format is actually a result of international discussion with space operators, where the need for a standard format were expressed and now CDMs are widely adopted. In addition, **Guideline B.1,** Provide updated contact information and share information on space objects and orbital events, is also applicable to the same SSA data providing process – Ms. Letizia argued –, as ESA is contributing to providing and receiving updates on its satellites' missions. LTS Guideline **B1.5** was underlined by the space debris engineer as well, explaining that ESA's so-called DISCOS database does not only store information on objects in orbit, but it also gives an open access to the data worldwide.

As a next step, after the data is received, – according to the space operational expert – the information is automatically retrieved and then processed in ESA's computational pipeline to determine the risk of collision. When needed, the Collision risk computation mechanism can also design the avoidance maneuver (CORAM). This conjunction assessment is applicable to the **Guideline B.4,** Perform conjunction assessment during all orbital phases of controlled flight, Ms. Letizia asserted. Furthermore, it was highlighted that ESA is making its tools and methodologies to analyze the collision risk and reduction strategies during the design of a mission available online, which also responds to **Guideline C.2,** Share experience related to the long-term sustainability of outer space activities and develop new procedures, as appropriate, for information exchange, on sharing information**.** The result of the computation is stored in a designated database, which is useful on the one hand for the engineers to perform statistics, on the other hand, it also functions as visualization to inform the flight control team in case of high-risk events.

The issue with performing maneuvers was also touched upon by the space engineer, which is two-folded, first the cost of fuel (which is negligible) and in terms of the impact on operations. Related to the latter effect, Ms. Letizia explained that for a short (i.e.. 15 seconds) maneuver, operation of a satellite may be halted for hours resulting an outage of data provided to the users and scientists. As Ms. Letizia emphasized, there were cases at the end of 2020 when her team had to perform two collision avoidance maneuvers in two days. Communication about such events was also mentioned as an important element when thinking of space sustainability, which activity relates to **Guideline C.4,** Raise awareness of space activities.

Although, with automated elements, collision avoidance maneuvers require an overall manual effort. More automation and machine learning elements may be a possible next step in handling conjunctions, (i.e.. predicting high-risk events) for which ESA has organized competitions for researchers, where anonymized operational CDMs were also distributed to support research in conjunction evaluation. Such activity can be linked to **Guideline D.1,** Promote and support research into and the development of ways to support sustainable exploration and use of outer space.

Last but not least, Ms. Letizia welcomed that the Guidelines for the Long-term Sustainability Outer Space Activities of the Committee explicitly addresses small satellites as an important answer to the large trend of satellite miniaturization.

Consequently, three elements were emphasized as possible solutions to the growing demands for collision avoidance in LEO that are, increased data quality and sharing, improved coordination methods and increased automation.

Ms. Letizia's presentation in the event recording starts here.

4. **Mr. Sittiporn Channumsin,** Chief of Astrodynamics Research Laboratory at the Geo-Informatics and Space Technology Development Agency (GISTDA, Thailand)

Mr. Channumsin started his presentation with the introduction of Thailand's Space Agency, called the Geo-Informatics and Space Technology Development Agency (GISTDA) with a headquarter in Bangkok.

The space researcher then dived into his representation, firstly highlighting the role of space object registration, launched into space, related to **Guideline A.5,** Enhance the practice of registering space objects, was put into scrutiny. Mr. Channumsin declared that Thailand is not part to the United Nations Registration Convention yet, however, Thailand has voluntary registered the country's Earth observation (EO) satellite system, called THEOS at the United Nations Office for Outer Space Affairs, following Resolution 1721 B (XVI). In addition, the space researcher declared that since 2020, Thailand has had its own national procedure of objects launched into outer space with two responsible authorities in the process, that are GISTDA and the Ministry of Foreign Affairs.

As a next topic, Mr. Channumsin talked about space safety operations and the role of AstroLab at GISTDA. AstroLab has three main missions that are research; cooperation and building research networks and clusters both in global and local level, (which relates to **Guideline C.3,** Promote and support capacity-building); and academic services. Within the research activities, there are four research areas that AstroLab focuses on –

according to Mr. Channumsin – that are, space-flight dynamics; on-board flight software for small satellites; space debris and asteroid; and space weather. Among the activities previously listed, there are two current projects in AstroLab, first, the development of an on-onboard flight software with the usage of the 'FLP platform', and second, a space traffic management project, called, ZIRCON. In the framework of the ZIRCON Project, in relation to **Guideline B.4,** Perform conjunction assessment during all orbital phases of controlled flight, space object categorization, conjunction assessment, and visualization are taking place with the use of the space flight safety domain, www.space-track.org. In the near future, the Chief engineer asserted that GISTDA is going to develop approaches for pre-launch conjunction assessment in line with **Guideline B.5,** Develop practical approaches for pre-launch conjunction assessment. In terms of space weather-related activities, it is the concrete plans of GISTDA to follow **Guideline B.6,** Share operation weather data and forecasts, and **Guideline B.7,** Develop space weather models and tools and collect established practices on the mitigation of space weather effects.

Mr. Channumsin's presentation in the event recording starts here.

Questions and Answers

In the Q&A session, Mr. Al Hashmi emphasized the crucial role that international cooperation plays related to the UAE National Space Science and Technology Center's progression, especially related to space sustainability and space situational awareness. Research carried out by the NSSTC, at a later stage then becomes important part of UAE's space policy, implemented by the UAE Space Agency as well.

Mr. Piso from ROSA discussed the importance of the ecosystem built with various stakeholders – universities, research institutes, companies, and non-governmental organization (NGOs). Within the ecosystem there are more than 3000 people involved now related to space activities and services. Due to the longer term of the space programmes and since the space strategy hasn't changed for more than two decades, they are able to track the learning processes and education, and utilization of education in the scientific and technical research and development (R&D). A good example was the development of a micro-satellite laboratory in the Institute of Space Science in Bucharest in 2002, where the target was to support 5-6 students, who later became the research leaders in that laboratory, teaching new students, and developing many activities and infrastructure now.

Ms. Letizia from ESA explained related to her comment on the 'operational reality', that those who engage in space missions have to take care of a safe and sustainable design and operation as a given and essential service when carrying out such activities, (i.e. emission in protected regions around the Earth). In addition, the space debris engineer recognized that when there is coordination between the satellite operator, the launch provider and the SSA networks, the identification of a satellite can work well without particular delays. However, trackability and identification of small satellites are also important and remain a challenge for conjunction assessment. We should also keep in mind, Ms. Letizia added, that active satellites still represent a small portion of the total number of objects circling on our orbits, hence there is a larger dimension of the space debris problem.

Mr. Channumsin highlighted the role of the Guidelines for the Long-term Sustainability Outer Space Activities of the Committee to keep our near-Earth environment sustainable, however, also called the attention to the importance that space actors should follow them through their activities.

The Q&A session of the morning event recording starts here

Afternoon Session

1. **Ms. Lauri K. Newman,** Conjunction Assessment Manager at NASA

Ms. Newman introduced NASA's Conjunction Assessment Risk Analysis (CARA) practices in her presentation. The Aerospace engineer also welcomed the adoption of the Guidelines for the Long-term Sustainability Outer Space Activities of the Committee and portrayed them an important milestone in ensuring that all nations can continue to benefit from the use of space for future generations as they represent best practices for the safe and responsible use of space.

During her intervention, Ms. Newman specifically referred to **Guideline B.4,** Perform conjunction assessment during all orbital phases of controlled flight that recommends performing conjunction assessment during all orbital phases of controlled flight. In accordance with **Guideline B.4,** NASA performs conjunction assessment for all operational missions during their entire mission lifetime. Ms. Newman elaborated that NASA's CARA Programme is responsible for performing conjunction assessment for the non-human space flight missions, which means that they support approximately 70 spacecrafts.

Ms. Newman also recognized that a significant increase in the volume in both diversity and activity in space means that it has become increasingly congested. The growing number of commercial ventures such as satellite servicing, in-space manufacturing, space tourism, and new technologies enabling small satellites and large constellations present additional serious challenges to use space in a stable and sustainable manner. Global awareness was mentioned by the aerospace engineer as a potential way of handling such trends, by publicly sharing flight safety related information and by coordinating on-orbit activities in a more responsible manner, related to **Guideline B.3,** Promote the collection, sharing and dissemination of space debris monitoring information.

Ms. Newman also noted that in December 2020, CARA published NASA Spacecraft Conjunction Assessment and Collision Avoidance Best Practices Handbook, where safety standards and best practices were enlisted that consider maneuverability, tracking, reliability, and disposal, that can be linked with **Guideline D.1,** Promote and support research into and the development of ways to support sustainable exploration and use of outer space. The Handbook also encourages the use of commercially available SSA data and for large constellations, and it encourages mitigating light pollution to ground-based astronomy. The need for new and better space situation awareness (SSA) capabilities, enhanced notifications and data sharing, and increased automation were among the most highlighted recommendations that Ms. Newman shared with the audience.

As Ms. Newman elaborated, NASA's conjunction assessment (CA) process comprises three phases, (1) CA screenings to identify close approaches between protected asset (the primary satellite) and any other space objects (secondaries). The next phase mentioned by the aerospace engineer was (2) CA risk assessment, which examines each of those close approaches produced by the screening activity to determine which may represent dangerous situations, therefore they require mitigation action. The third phase introduced was (3) CA's direct mitigation action that usually involves a trajectory change for the primary object, but it can also mean sharing information with the secondary object's operator, so they can perform an avoidance maneuver themselves.

Finally, with respect to **Guideline B.5,** Develop practical approaches for pre-launch conjunction assessment, Ms. Newman emphasized that, NASA takes steps to avoid co-location of spacecraft to the extent practical, planning for robust communications and data-sharing between co-located spacecraft when co-location is unavoidable, and analyzing planned mission trajectories to determine the anticipated number of potential conjunctions.

Ms. Newman's presentation in the event recording starts here.

2. **Ms. Francisca Parra Rojas,** Officer at the Air Force of Chile

Ms. Parra Rojas' presentation introduced the Contribution of the National Satellite System (SNSAT) of Chile to the Guidelines for the Long-term Sustainability Outer Space Activities of the Committee. It was further noted that the Chilean National Space System has 3 main pillars, SNSAT; the National Space Centre; and the National Spatial Institution. SNSAT itself involves, Earth observation (EO), space situational awareness (SSA), Telecommunications, and Launching, and Positioning System activities. In order to carry out the Spatial Development Strategy of SNSAT, there are four pillars that Chile takes into consideration, the technology; financial; normative; and institutional frameworks.

According to Ms. Parra Rojas, SNSAT consists of two entities, the Spatial Operation Group (GOE) and the Aero-photogrammetric Service (SAF). Moreover, SNSAT has four subsystems aiming to support the various capabilities to be achieved. The subsystems are, Geospatial Information Management; National Production; National Satellite; and Telecommunication Services.

In terms of the Guidelines for the Long-term Sustainability Outer Space Activities of the Committee, Ms. Parra Rojas presented 4 specific guidelines to showcase the Chilean Airforce's space activities related to space sustainability. According to **Guideline A.1,** Adopt, revise and amend, as necessary, national regulatory frameworks for outer space activities, and **Guideline A.2,** Consider a number of elements when developing, revising or amending, as necessary, national regulatory frameworks for outer space activities, Chile has had a permanent participation in the United Nations Committee on the Peaceful Uses of Outer Space and its subcommittees. In addition, besides Chile's current space regulations, The National Satellite System Program has started the planning of a new norm about space development. For instance, there is a ministerial decree currently in revision, about the emission standard of light pollution, considering the valuable environmental and cultural heritage recognized internationally of the territory, especially in northern Chile

Ms Parra Rojas also expressed that **Guideline A.5,** Enhance the practice of registering space objects, has been adopted through a ministerial decree a few years ago, establishing the Chilean registry of space objects launched into orbit and the mandatory practice of registration of launched space crafts from Chile.

With respect to **Guideline B.3,** Promote the collection, sharing and dissemination of space debris monitoring information, it was argued that one of the main purposes of SNSAT's subsystems called, Geospatial Information Management, is to strengthen the capacity for storage, processing, and distribution of geospatial information. It is also planned to be used for space debris monitoring through the creation of a unified space database. In addition, a Chilean SSA project was mentioned by Ms. Parra Rojas, titled "All Sky" Project, which is aimed to track space objects in orbit and to predict their trajectories.

Lastly, LTS Guideline, **B.6,** Share operational space weather data and forecasts, was put into scrutiny by the space officer, stating that through SNSAT's second subsystem, National Productions, Chile aims to include space weather monitoring and forecast in the future.

Ms. Parra Roja's presentation in the event recording starts here.

3. **Mr. Jacob Geer,** Head of Space Surveillance and Tracking at UK Space Agency

Mr. Geer explained in his intervention that the UK supports the Guidelines for the Long-term Sustainability Outer Space Activities of the Committee from two directions, directly by developing its SST capability, and indirectly, through investing in ESA and national research and development capabilities.

In relation to the Guidelines for the Long-term Sustainability Outer Space Activities of the Committee, **Guideline B.2,** Improve accuracy of orbital data on space objects and enhance the practice and utility of sharing orbital information on space objects; Guideline **B.3,** Promote the collection, sharing and dissemination of space debris monitoring information; and **Guideline B.4,** Perform conjunction assessment during all orbital phases of controlled flight, were emphasized by Mr. Geer. It was explained that the UK Space Operations Centre where SST was set up in the UK was created in 2008 by the Royal Air Force, to which civil analysts joined in 2016, and then created the National Space Operations Centre in 2018. In collaboration with other key actors, the UK co-founded the EU SST consortium in 2015 to monitor orbital events. In terms of international cooperation, it was noted that the UK embeds in the US Combined Space Operations Center, and it actively supports the United Nations Committee on the Peaceful Uses of Outer Space and the Inter-Agency Space Debris Coordination Committee Space Debris Mitigation Guidelines (IADC Guidelines) and analysis.

It was explained by Mr. Geer that UK SST activities consists of three categories, sensors, data processing, and analysis. With regards to sensor activities, the UK awards grants to industry to develop new lower-cost sensor technologies, it maintains and uses current UK sensors and shares data with academic partners. Furthermore, in terms of data processing, the UK develops national software, and also grants awards to industry to use artificial intelligence (AI) & Machine Learning for SST. Related to the third activity, analysis, it was expressed that the UK builds skills and expertise in its civil and military orbital analysts and investigates cutting edge algorithms for SST analysis.

Moving on to **Guideline B.6,** Share operational space weather data and forecasts; **Guideline B.7**, Develop space weather models and tools and collect established practices on the mitigation of space weather effects; **Guideline D.1,** Promote and support research into and the development of ways to support sustainable exploration and use of outer space;. and **Guideline D.2,** Investigate and consider new measures to manage the space

debris population in the long-term, Mr. Geer argued that the UK is a leading contributor to the European Space Agency (ESA), investing to its Space Safety Programme. Through the Space Safety Programme, ESA addresses threats originating from space and mitigates Space Weather risk through an innovative mission that secures and enhances the observational data, necessary for forecasting. Furthermore, the ESA Programme demonstrates in-orbit servicing missions and technologies, and underpins research in debris detection, cataloguing and mitigation.

Furthermore, in relation to Guidelines **D.1,** and **D.2,** in a national point of view, Mr. Geer highlighted that the UK Space Agency (UKSA) provides grant funding to support pioneering projects to advance SST in the UK space sector, and also it supports businesses ranging from large to small companies to develop cutting-edge innovations to combat space debris. Finally, it was stated that UKSA has introduced new SST technology and services, which potentially will deliver new national sensors for the SST mechanism as well.

Mr. Geer's presentation in the event recording starts here.

4. **Mr. Valanathan Munsami,** CEO, South African National Space Agency (SANSA)

Mr. Munsami highlighted two of the key South African National Space Agency (SANSA) programs relevant to the Guidelines for the Long-term Sustainability Outer Space Activities of the Committee during his speech: the most advanced ground segment in Africa, and the only space weather center in the continent. As far as the ground segment that is operational since 1960, it was noted that the segment has a 24/7 operation, and it provides telemetry tracking and command services for the satellite process. Moreover, the ground segment provides launch support when a spacecraft passes through Africa, also it helps orbital corrections and maintenance from low Earth orbit (LEO) to geostationary orbit (GEO). The second element, SANSA's Space Weather Center, established in 2010, helps to look at the interaction of the sun with the Earth's magnetosphere and investigates how coronal mass ejections and similar events affect us and technologies on Earth and satellites in space. The Space Weather Center of SANSA was relaunched after an upgrade in 2018, and in addition, a new building is opening soon, to serve as a new 24/7 Regional Space Weather Center.

Mr. Munsami continued his presentation by emphasizing **Guideline B.7,** Develop space weather models and tools and collect established practices on the mitigation of space weather effects, and its relevance to SANSA's space weather applications. It was explained that Guideline B.7 does not only call for the integration of space weather thresholds into space launch criteria, but it also encourages space actors to mitigate

anomalies for on-orbit operations and for the collection, collation and sharing of space weather information. In addition, related to Guideline B.7, there is also a requirement for a common formatting for reporting information, and policies on sharing information. Last but not least, Mr. Munsami added, Guideline B.7 encourages training and knowledge transfer with special focus on emerging space nations.

It was also stated during the intervention that SANSA has many space weather activities that correlates to Guideline B.7. For example, SANSA has been taking part in the Working Group on the Long-term Sustainability of Outer Space. Furthermore, SANSA is part of the United Nations Committee on the Peaceful Uses of Outer Space Expert Group on Space Weather. The Regional Space Weather Centre of SANSA also provides space weather information to the African Region, and it also serves as a designated provider State for regional space weather information to the aviation sector. Finally, SANSA is the lead African institution on Space Weather under the International Civil Aviation Organization (ICAO) African Regional Office.

As far as capacity building, Mr. Munsami elaborated that university students are being supported yearly. Moreover, a research chair in solar physics from abroad has been hired as it is one of the activities that SANSA wanted to boost its capacity on.

An additional interesting element was discussed during the intervention, that since a new regulation in the aviation sector, called Information Provision from ICAO came into effect, before a flight takes off, the pilot has to provide space weather information on board, which information needs to come from a space weather center. Such space weather information may include effects on high frequency radio communications, satellite communications, global navigation satellite system (GNSS) navigation and surveillance, and radiation exposure at flight level. Such requirements also represent the necessity of space weather information sharing and the role of space weather centers. In addition, the Space Weather Center of SANSA also helps measuring space, and space weather effects on satellites from the ground.

In terms of the future, Mr. Munsami stated, SANSA is trying to work on integrating the space capabilities into the ground segment in terms of launch support and in-orbit testing, and orbital correction that Guideline B.7 implies not only in a country level, but in a global perspective, as space weather centers are all connected worldwide.

Mr. Munsami's presentation in the event recording starts here.

Questions and Answers

During the Questions and Answers, Ms. Newman elaborated on the relationship between NASA, the US. Department of Commerce, and the US. Department of Defense

in terms of space traffic management and space sustainability. Furthermore, Ms. Newman reflected on the transformation from the automated element of the conjunction assessment process into the human part of the mechanism and highlighted the need to find a way to imply automated communication between operators.

Ms. Para Rojas also commented on the process of registration of space objects related to Guideline A.5, Enhance the practice of registering space objects, and the economic factor of space sustainability in Chile.

Mr. Geer made remarks on appearing elements of co-dependency, co-investment and soon, cohabitation related to space sustainability. Additionally, outreach methods to the scientific and academic community were explained. Mr. Geer also expressed that strength of collaboration is necessary between military and civil partners in order to make sure that they can successfully monitor space, understand collisions, space weather, etc.

Mr. Munsami expressed his views on common formatting related to SANSA, Earth Observation and space sustainability, and elaborated on the relationship between SANSA and external satellite operators. Lastly, Mr. Munsami commented on the question of dual use from South Africa's point of view and illustrated the transition that has been taking place from the military to the civilian space programme's dominance in the country.

The Q&A session of the afternoon event recording starts here

Summary of interventions

Throughout the morning and afternoon panel sessions, the most popular Guidelines for the Long-term Sustainability Outer Space Activities of the Committee that space agency operators referred to were, **Guideline B.4** Perform conjunction assessment during all orbital phases of controlled flight; **Guideline B.6** Share operational space weather data and forecasts; **Guideline B.7** Develop space weather models and tools and collect established practices on the mitigation of space weather effects; and **Guideline D.1** Promote and support research into and the development of ways to support sustainable exploration and use of outer space

Important activities such as space traffic management (STM), space situational awareness (SSA), collision avoidance, conjunction assessment, space weather, and related R&D as well as capacity building were considered in relation to space sustainability, and implementation of the Guidelines for the Long-term Sustainability Outer Space Activities of the Committee.

It was also recognized by all speakers that the risk of space sustainability is already an apparent and pressing issue that is becoming more and more critical with the growing mega-constellation satellite population and growing variety of space sector actors and activities. As many presenters underlined, it is only through concerted efforts – both in terms of international, cross-sectoral, and multidisciplinary approaches – that space debris mitigation will be successful in the long-term.

Finally, all speakers welcomed the adoption of the Guidelines by the Committee on the Peaceful Uses of Outer Space and urged that, even though the Guidelines are voluntary, space actors should not underestimate their potential positive impact when implemented. However, serious efforts need to be taken for a wider and more thorough implementation across the global space sector, so that society can continuously enjoy space services into the long-term.