FINAL REPORT

SPACE GENERATION ADVISORY COUNCIL

IN SUPPORT OF THE UNITED NATIONS PROGRAMME ON SPACE APPLICATIONS

SPACE GENERATION FUSION FORUM 2013

2013 | SPACE GENERATION ADVISORY COUNCIL

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Letter from SGAC Co-Chairs

It is our great pleasure to present you the report of the second Space Generation Fusion Forum in Colorado Springs, USA, held on April 7th and 8th, 2013. The event gathered 47 students and young professionals from 15 countries to discuss pertinent issues affecting space activities. Four sessions were organised: “Long Term Sustainability of Space”, “Operational Data Exchange and Sharing of Space Assets”, “Innovative Space Exploration Strategies” and “Regional Space Programmes: Risks and Benefits”. Based on last years’ Fusion Forum success, four panels comprising of a selection of delegates and space industry leaders were successfully included in this years’ event. This approach has proven to be a very effective way to articulate the opinions of the new space generation.

It is SGAC’s mission to help university students and young professionals participate in the global space industry. Six Global Grants scholarship winners were selected based on their experience and relevant backgrounds. These Global Grant winners were given the opportunity to support one of the 4 panels. Additionally, the Fusion Forum featured two more scholarships thanks to the Washington Space Business Roundtable. Up until April 2012, only the annual Space Generation Congress provided an opportunity for young space professionals and university students to network with similarly enthusiastic individuals from all over the world, to learn about their sector and to provide their views of the space community. Last years’ inaugural Fusion Forum has opened a new opportunity for the younger generation to discuss their opinions, share their views and expand their horizons. We hope that both of these events continue to grow and evolve, bringing together the high potentials of the next generation.

At this point we would like to thank our team of highly dedicated volunteers, whose work is the reason for the on-going success of the Fusion Forum, especially Stephen Ringler, Space Generation Fusion Forum Manager. This event would not have been possible without the dedication, planning and motivation of the organising team. Our special thanks go to the Space Foundation, who hosted the event and again supported us tremendously during its organisation. Last but not least, SGAC would like to extend a thank you to all of the event’s sponsors who helped make the Fusion Forum a reality.

We are proud of the outcome of the second Space Generation Fusion Forum and look forward to building on its success and momentum.

Chijioke (CJ) Nwosa

SGAC Chair

Christopher A. Vasko

SGAC Co-Chair

Letter from Fusion Forum Managers

After several years of dreaming about bringing an international event for young professionals and university students back to the United States, the inaugural Space Generation Fusion Forum was held last year. As a result of its great success, the second Space Generation Fusion Forum was organized and has settled a trend to make the Fusion Forum an annual event going forward.

The organization team of 10 individuals spread throughout the United States and Europe worked adeptly to pull together the event to be able to host the final 47 competitively-selected delegates from 15 countries. From the delegates' demographics and number of scholarships awarded, to the high-level speakers and irreproducible energy of an SGAC event, the team ensured that event lived up to the high expectations.

It goes without saying, that the successful realization of the Space Generation Fusion Forum was very meaningful. The credit for this achievement is equally shared among all involved: SGAC's partners, the event sponsors, the delegates, and, of course, the SGAC volunteer organizing team.

SGAC is proud of the second edition of the Space Generation Fusion Forum and looks forward to many more successful events of its kind.

We hope you will join us for future events!

Andrea Jaime

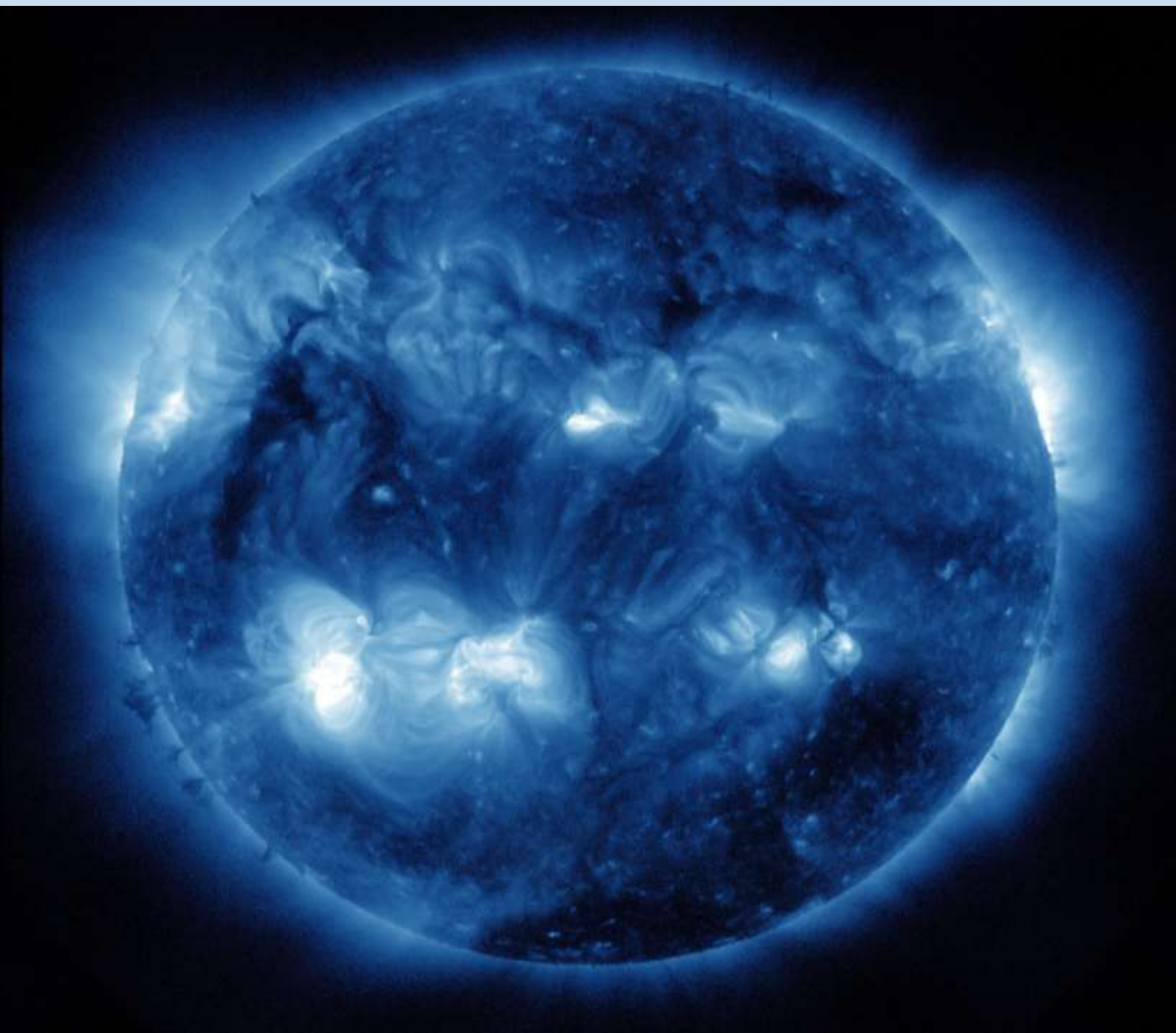
SGAC Executive Director

Space Generation Fusion Forum Manager

Stephen Ringler

Generation Fusion Forum Co-Manager

FUSION FORUM OVERVIEW



Delegates of the 2nd Space Generation Fusion Forum

The second annual Space Generation Fusion Forum was held on April 7 and 8, 2013 at the Broadmoor Hotel, Colorado Springs, USA. It brought together top students and young professionals from all over the world to focus on key space topics.

The Fusion Forum brought delegates together for one and a half days. During the first day, senior space industry professionals presented their views on space policy issues and gave relevant advice to the delegates. This first day concluded with a networking reception attended by both the participants and the speakers. In a relaxed atmosphere, the audience could exchange their thoughts and discuss the various topics raised by the speakers throughout the day.

On the second day, four panels were conducted on the following topics:

1. Long Term Sustainability of Space
2. Operational Data Exchange and Sharing of Space Assets
3. Innovative Space Exploration Strategies
4. Regional Space Programmes: Benefits and Risks

The panellists were chosen for their relevant experience and knowledge of the topics covered. Panellists prepared materials for discussion relevant to their panel topic. During the hour-long discussions, the audience actively participated, voicing their opinions and asking questions for the panel and other delegates during a question and answer session.

The Fusion Forum concluded with a vote for the Most Valuable Participant (MVP). The winner, Lewis Groswald from the United States, will present the Fusion Forum's report and findings at the American Institute of Aeronautics and Astronautics (AIAA) Space 2013 Conference to be held in California in September 2013. The delegates also took part in the Opening Ceremony and the Opening Reception of the National Space Symposium on April 8.

The Fusion Forum was hosted by the Space Foundation in conjunction with the National Space Symposium. Nearly half of the Fusion Forum participants attended the Symposium, with more than 9000 international space professionals. The Fusion Forum participants were invited to the New Generation events held throughout the week.

Fusion Forum participants attending the New Generation Luncheon at the NSS

Leroy Chiao

Special Advisor - Human Spaceflight, Space Foundation

Educated as an engineer, Space Foundation Special Advisor - Human Spaceflight, Dr. Leroy Chiao, works in business and academia. He is also a consultant, speaker and former NASA astronaut. Chiao grew up in Danville, Calif., and earned a Doctor of Philosophy degree in chemical engineering from the University of California at Santa Barbara. A native English speaker, he also speaks Mandarin Chinese and Russian. He has flown three Space Shuttle missions: STS-92 Discovery, Oct. 11-24, 2000; STS-72 Endeavour, Jan. 11-20, 1996; and STS-65 Columbia, July 8-23, 1994. In addition, he flew as Flight Engineer 1 aboard Soyuz TMA-5 to the International Space Station (ISS), where he served as commander and NASA science officer during Expedition 10. Chiao received the NASA Distinguished Service Medal in 2004. After a 15-year career with NASA, he left in 2005 to work and consult on a number of projects. In 2009, he served as a member of the Review of United States Human Space Flight Plans Committee, and currently serves on the NASA Advisory Council. He holds appointments at Rice University and the Baylor College of Medicine, and is involved in educational programmes. He also serves on the editorial board of New Space Journal. An instrument-rated pilot, Chiao has logged over 2,900 flight hours in a variety of aircraft.

Carissa Christensen

Managing Partner, The Tauri Group

Carissa Bryce Christensen is a founder and Managing Partner of The Tauri Group, an analytic consulting firm based in Alexandria, Virginia. Ms. Christensen is a recognized expert in commercial space and for 25 years has engaged the leading edge of the space industry with innovative analysis of space systems, industry economics, advanced technologies, unique regulatory requirements, and underlying demand. Ms. Christensen conceived and originated data resources that remain industry standards. Those include: an innovative, industry-wide, demand-based global market forecast for commercial satellite services, which became a benchmark in better understanding industry dynamics; the first comprehensive economic measurement of the commercial satellite industry through the development of the Satellite Industry Association's (SIA) annual indicators; a re-definition of the segments of the space industry in the inaugural Space Report published by the Space Foundation; and, an industry model, and measures of revenue, investment, and employment, of the emerging commercial human spaceflight industry for the Commercial Spaceflight Federation (CSF). These resources reflect consistent commitment to an objective viewpoint, rigorous analysis, and realistic characterization of trends. Her on-going work with government agencies, industry organizations, launch firms, and satellite manufacturers and operators helps decision makers better understand market positioning, future demand for space services, and competitive dynamics. For example, recent projects led by Ms. Christensen have evaluated changing orbital launch prices for commercial satellites and analysed segments of the suborbital launch market. She is currently the external space industry expert for the sector-by-sector tier-by-tier industrial base analysis being conducted by the DoD Office of Manufacturing and Industrial Base Policy (MIBP). Ms. Christensen's publications include contributions to peer-reviewed journals, industry publications, books, and conference proceedings. She has often been quoted in trade and popular media, including Wired, the CBS Evening News, Space News, and the Los Angeles Times.

Richard DalBello

Vice President, Government Affairs, Intelsat General Corporation

Richard DalBello is responsible for the government relations and public policy efforts of Intelsat and Intelsat General. In this role, Mr. DalBello represents the company before the U.S. Congress and numerous U.S. and international policy bodies. With more than 20 years of experience, Mr. DalBello is well-versed in satellite communications and government space policy issues. He previously served as President of the Satellite Broadcasting and Communications Association and for more than three years as the President of the Satellite Industry Association (SIA). Mr. DalBello's previous positions include General Counsel for Spotcast Communications Inc. and Vice President of Government Affairs, North America for ICO Global Communications, a provider of mobile satellite communications services. He also served for four years as the Assistant Director for Aeronautics and Space in the White House Office of Science and Technology Policy. Mr. DalBello is currently serving on the National Space-Based Position, Navigation, and Timing Advisory Board, The Advisory Committee of the Secure World Foundation, and the United Nations Institute for Disarmament Research (UNIDIR) Expert Group on the International Code of Conduct. Mr. DalBello earned a Bachelor of Science degree in Political Science from the University of Illinois, a Master's degree in Law from McGill University, and a Doctorate in Jurisprudence from the University of San Francisco.

David Finkleman

Senior Scientist, Center for Space Standards and Innovation (CSSI), Analytical Graphics, Inc. (AGI)

Dr. David Finkleman, a leading authority on civil, commercial, and military space systems, serves as CSSI's senior scientist. In this capacity, he evaluates and designs orbit estimation and space system simulation techniques while expanding the use of standards in space research. Before coming to CSSI, Finkleman was a member of the Senior Executive Service (SES) and served as Director of Analysis and Chief Technical Officer for the North American Aerospace Defense Command (NORAD) and U.S. Space Command, Peterson Air Force Base, CO. He led U.S. and Canadian personnel responsible for all analytical and technical matters regarding U.S. military satellite systems; space surveillance; ballistic missile warning and defense; and all North American aerospace sovereignty and control capabilities. Finkleman is also currently affiliated with the International Standards Organization and SkySentry, LLC.

Mark Kinnersley

Director, MPCV ESM Resident Liaison at Astrium North America

With over 20 years' experience in international aerospace management encompassing business development, small company startup, program management and engineering/ development programs. As well as with international project experience ranging from Europe, North America, Russian, Asia and Australia. Dr. Mark Kinnersley is the current resident liaison for Astrium North America for the European contribution to the Orion Multi-purpose Crew Vehicle, the Service Module. An ESA - NASA cooperation within the field of deep space human spaceflight, ESA will supply the Service Module for the Orion vehicle with Astrium as the prime contractor in Europe.

Lon Levin

President, SkySevenVentures & co-founder, XM Satellite Radio

Lon Levin is an executive and entrepreneur with over 25 years of experience in space, new media, and telecommunications industries. Lon is President of SkySevenVentures, which works with, helps manage, and invests in new technology companies, particularly space-based businesses, including Sentinel Satellite (CEO), Integral Systems, Transformational Space (Chief Strategic Officer), Terrestar Networks, Slacker Radio (Senior Advisor to CEO and Board), and Near Earth LLC. Lon speaks at industry, academic, and government conferences on space business, policy, and finance. Lon is the cofounder of XM Satellite Radio and played an integral role in the formation and development of other satellite, media, and wireless companies including Mobile Satellite Ventures, XM Canada, Motient Corporation, American Mobile Satellite Corporation, and TerreStar. Before his corporate career, Lon was a partner in the law firm Gurman, Kurtis, Blask & Freedman, where he specialized in space, satellite, media, and wireless matters. He started his career as an attorney at the Federal Communications Commission. Throughout the 1990s, Lon served as a United States Delegate at many United Nations International Telecommunication Union conferences. Lon just completed serving on the Department of Defense sponsored CSIS commission to study the Health of the Space Industrial Base and Export Controls. Lon holds two mobile satellite service patents. Lon is a member of the Executive Committee and the Board of Directors of the Space Foundation, the Board of Directors of the Planetary Society, the Board of Governors of the National Space Society, and the Board of Directors of International Association of Space Entrepreneurs. He was a founding board member of the Satellite Industry Association and was its co-chairperson from 1996-98. Lon is a member of the Board of Directors of the Cultural Development Corporation of Washington, DC, which helps artists secure affordable housing and work places. Lon was inducted into the Space Foundation Technology Hall of Fame in 2002.

Elliot Pulham

Chief Executive Officer, Space Foundation

Mr. Pulham is the chief executive officer of the Space Foundation. Prior to joining the Space Foundation, he was senior manager of public relations, employee communication and advertising for all space programs of The Boeing Company, where he served as spokesperson at the Kennedy Space Center for a half-dozen space shuttle flights. Pulham's non-profit experience includes serving as executive director of the Kona-Kohala, Hawaii, Chamber of Commerce, and as director of corporate communication for the Boeing Employees Good Neighbor Fund. He is a graduate of the Kamehameha Schools and an alumnus of the University of Hawaii.

Victoria Samson

Washington Office Director, Secure World Foundation (SWF)

Victoria Samson is the Washington Office Director for Secure World Foundation and has more than fourteen years of experience in military space and security issues. Among her significant previous positions, Samson served as a Senior Analyst for the Center for Defense Information (CDI), where she leveraged her expertise in missile defense, nuclear reductions, and space security issues to conduct in-depth analysis and medial commentary. Prior to her time at CDI, Samson was the Senior Policy Associate at the Coalition to Reduce Nuclear Dangers, a consortium of arms control groups in the Washington, D.C. area where she worked to share information quickly and efficiently between Congressional staffers, members of the media, embassy officials, citizens and think-tanks dealing with national missile defense and nuclear weapons reductions. Before that, she was a researcher at Riverside Research Institute, where she worked on war-gaming scenarios for the Missile Defense Agency's Directorate of Intelligence. Known throughout the space and security arena as a thought leader on policy and budgetary issues, she is also a prolific author of numerous op-eds, analytical pieces, journal articles, and electronic updates on missile defense and space security matters.

Mark Sirangelo

Corporate Vice President, Sierra Nevada Corporation & Head, Sierra Nevada Space Systems

Mr. Sirangelo leads Sierra Nevada Space Systems, a producer of satellites, space transportation vehicles, propulsion systems, and space subsystems. Sierra Nevada has been involved during its 20+ years of combined activity in over 400 space missions and has produced over 4,000 systems, subsystems and components for a wide variety of earth orbit and planetary missions. SNC is also the owner and prime developer of the Dream Chaser, an orbital vehicle transportation system currently being funded in partnership with NASA as a replacement vehicle for the Space Shuttle. Mr. Sirangelo was formerly the Chairman & CEO of SpaceDev, Inc., prior to its merging with SNC and has spent his career leading aeronautics, space and technology companies. Mr. Sirangelo's industry board memberships include being the Chairman Emeritus of the Commercial Spaceflight Federation, the founding and current Chairman of eSpace, The Center for Space Entrepreneurship and a Trustee for the Aeronautics Industries Association. His charity boards include being a board member and trustee of the National Center for Missing & Exploited Children and a founder, Vice Chairman and Treasurer of the International Centre for Children. Corporate and personal awards include NASA/Space Foundation's Technology Hall of Fame, the Defense Industry's Fast Track 50, Deloitte's Fast Track 500, being a finalist in Ernst &Young's Entrepreneur of the Year and on Inc. Magazine's top 200 companies. Mr. Sirangelo holds Doctorate, MBA and Bachelor of Science degrees, has been scientifically published, has served as an officer in the US Military and is a licensed pilot.

Roger W. Teague

Director of Strategic Plans, Programs and Analyses, Headquarters Air Force Space Command

Brig. Gen. Roger W. Teague is Director of Strategic Plans, Programs and Analyses, Headquarters Air Force Space Command, Peterson Air Force Base, Colo. He is responsible for programming and advocating resources for the command; planning for the command's force structure, bases and facilities; managing the command's international relations and foreign disclosure programs; and overseeing the command's modelling, simulation and scientific analysis activities. General Teague was commissioned in 1986 as a graduate of the U.S. Air Force Academy. His career includes a broad range of assignments primarily acquiring, operating and supporting space control, missile warning, and communications systems. He has commanded at the squadron, group and wing levels and served on the staffs at Air Force headquarters. He commanded the 4th Space Operations Squadron, Schriever AFB, Colo., where he led his unit during launch, test and operational activation of three Milstar communications satellites. He also commanded the Space-Based Infrared Systems (SBIRS) Space Group and the SBIRS Wing, leading development, launch, test and on-orbit checkout of the final Defense Support Program satellite, the first two SBIRS polar orbiting payloads, and the first SBIRS geosynchronous satellite. Prior to his current assignment, he served as Vice Commander, Space and Missile Systems Center, Los Angeles AFB, Calif.

Johann-Dietrich Wörner

Chairman of the Executive Board, German Aerospace Center (DLR)

Johann-Dietrich Wörner was born in Kassel in 1954. He has been Chairman of the Executive Board of the German Aerospace Center (DLR) since 1 March 2007. He studied civil engineering at the Technische Universität Berlin and the Technische Hochschule Darmstadt, from where he graduated in 1985. In 1982, as part of his studies, he spent two years in Japan, investigating earthquake safety. Until 1990 Wörner worked for the consulting civil engineers König und Heunisch. In 1990 he returned to Darmstadt University, where he was appointed to a professorship in Civil Engineering and took over as Head of the Testing and Research Institute. Before being elected President of the Technische Universität Darmstadt in 1995, he held the position of Dean of the Civil Engineering Faculty. Wörner has been honoured with a series of prizes and awards such as the Prize of the Organisation of Friends of the Technische Universität Darmstadt for 'outstanding scientific performance'. He was also appointed to the Berlin Brandenburg Academy of Sciences and is a representative of the Technical Sciences Section of the German Academy of Sciences Leopoldina. Wörner has received honorary doctorates from the State University New York (USA), the technical universities of Bucharest (Romania) and Mongolia, the Saint Petersburg University for Economics and Finance (Russia), and École Centrale Lyon (France). He has been honoured by the German state of Hesse and the French government. Wörner is Vice President of the Helmholtz Association; he is also a member of various national and international supervisory bodies, advisory councils and committees. He was a member of the board of École Centrale Paris and École Centrale Lyon, the Convention for Technical Sciences (acatech) and the supervisory board of Röhm GmbH, to name just a few. Furthermore, he was appointed to the energy expert group of the German Government. He continues to be a member of the advisory boards of several universities such as the Technische Universität Berlin and the IST Lisboa.

The success of the 2013 Fusion Forum was made possible thanks to participation of high-level speakers and delegates from around the world. Of the young adult delegates, 18 were selected to provide their perspectives on one of the four panels. The Fusion Forum further enabled opportunities to network and learn from many high-level international space leaders through participation in the opening ceremony of the 29th Annual National Space Symposium.

Upper-Left: Johann-Dietrich Wörner / Upper Right: Mark Sirangelo
Below: Some of the speakers and Supporters with the Fusion Forum 2013 Organizing

Day One

To officially open the Fusion Forum, Andrea Jaime introduced the event on behalf of SGAC. Elliott Pulham and William Parker then spoke on behalf of The Space Foundation, expressing their support and enthusiasm for the Fusion Forum, and emphasizing the importance of the youth perspective and the international perspective that the Fusion Forum provides. These opening words were followed by a speech by Mr Mark Sirangelo, who gave an overview of Sierra Nevada's work, including their critical role in the landing of the Curiosity rover on Mars, the possibilities of standardization of small satellite development, and the exciting developments of Sierra Nevada's Dream Chaser. Mr Sirangelo discussed the benefits of using partnerships to maximize capability, concluding by saying that the upcoming years will be exciting ones in the space field, years that could well see developments that change the world.

After the keynote address, four speakers – specialists in the Fusion Forum panel topics – expressed their views. On the topic of *Long Term Sustainability of Space*, Brigadier General Roger Teague discussed the important role of Fusion Forum attendees in preserving the space enterprise. The optimization of this enterprise is becoming increasingly reliant on global partnerships and the specifications and procedures that enable these partnerships. Due to this, connections made at the Fusion Forum will prove beneficial to delegates and to the space enterprise in the future. Regarding the topic of *Operational Data Exchange and Sharing of Space Assets*, David Finkleman discussed the importance of data sharing for protection of the space environment. Such sharing is becoming essential, necessitating broad participation internationally and between commercial competitors, and frameworks should be developed to enable this. On the topic of *Innovative Space Exploration Strategies*, Leroy Chiao brought his extensive experience of international collaboration aboard the International Space Station to Fusion Forum attendees. Having trained for ISS flights in Russia, Chiao relayed first-hand how different approaches to technical projects between cultures present both challenges and opportunities, and discussed the benefits that space project collaboration has beyond the space sector. Finally, on the topic of *Regional Space Programmes: Benefits and Risks*, Carissa Christensen presented a picture of regional space programs around the globe, sparking discussion on the effects of budgets, how to define regional programs, and what makes good partnerships on the regional level and beyond.

In the evening, the attendees participated in a reception, sponsored by AGI, with fellow delegates, speakers, and other supporters of the Fusion Forum.

Fusion Forum delegates interacting during breaks

Day Two

In the morning session of day two, four panels were held. The panels examined key questions facing the space sector and international community at large, and provided input to international thinking from the next generation of space professionals.

The first panel, *Long Term Sustainability of Space*, discussed countries' obligations in the realm of preserving the space environment, the need for trust and confidence building measures, the opportunities that the pressure of the current fiscal environment can present, and the need to employ both technical and policy solutions. The second panel, *Operational Data Exchange and Sharing of Space Assets*, focused on data exchange toward the goal of improved space situational awareness and a more sustainable space environment. National regulations were discussed as a mechanism for increasing this type of exchange, which will need to consider both space and ground segments. The third panel, *Innovative Space Exploration Strategies*, provided both excitement for upcoming capabilities and practical concern for what can realistically be accomplished. The need for solid policy underpinnings to move the space sector in new directions, more hours of experience for humans beyond low Earth orbit, and inspiration beyond the 40-year-old model of Apollo, were all highlighted. The fourth panel, *Regional Space Programmes: Benefits and Risks*, discussed how regional space programs might be defined and how their benefits may be measured. Panellists discussed that often cooperation develops organically from the bottom up, and that cooperation is not necessarily a good thing in every situation, and its benefits should be evaluated before engaging with partners on any given project. More details on the panel discussions are available later in the report.

In addition to the above panels, keynote speakers Johann-Dietrich Wörner, Mark Kinnersley, and Lon Levin each addressed Fusion Forum attendees on day two.

To conclude the forum, Lewis Groswald was chosen as the winner of the AIAA Most Valuable Participant (MVP) award, which will allow him to represent SGAC by presenting the Fusion Forum report at the AIAA's SPACE 2013 conference.

Finally, attendees were introduced to the Space Foundation's 29th Annual National Space Symposium by participating in the Space Foundation's New Generation Leadership Exchange and Networking Reception which gave delegates the opportunity to interact with today's top space sector leaders from government and industry in an informal setting.

MVP Winner Lewis Groswald (middle) with Fusion Forum Managers

FUSION FORUM PARTICIPATION WITHIN THE NATIONAL SPACE SYMPOSIUM

The 29th National Space Symposium was held from April 8th to 11th at the Broadmoor Hotel, Colorado Springs, USA. Over 9,000 participants from the US and 30 other countries gathered together to participate in this huge space event. In addition to organising the Fusion Forum, SGAC actively participated in the activities of the Symposium including the New Generation Space Leaders Programme.

Many of the Fusion Forum delegates stayed for the entirety of the National Space Symposium. Fusion Forum delegates were invited to participate in most of the National Space Symposium events and all of the New Generation Space Leaders Programme, which included: 1) attending plenary sessions, 2) visiting the exhibition hall, 3) speed mentoring with current space sector leaders, 4) attending networking events, and 5) participating in the New Generation Leader's workshops "*A Fresh Take on Old Concepts: Reusable Launch Vehicles, Smallsats and Satellite Servicing*" and "*Good Management – The Path to Success*".

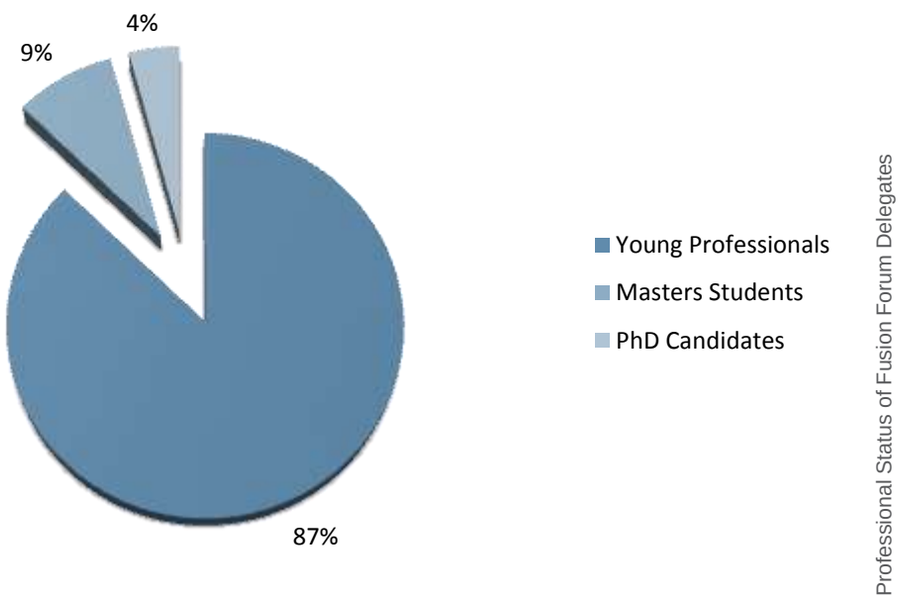
On Wednesday, April 10th, SGAC was highlighted on the National Space Symposium programme. Andrea Jaime and Stephen Ringler highlighted the results of the Fusion Forum on the National Space Symposium main stage, while also encouraging National Space Symposium attendees to interact with Fusion Forum delegates and discussing the benefits of SGAC events like the Fusion Forum to current space leaders and to the future of the industry. At the end of the SGAC presentation, Andrea Jaime introduced all of the Global Grant winners on the stage.

fusion forum statistics

Forty seven delegates participated in the second Fusion Forum. 9 of the delegates were members of the organising team. Speakers, moderators and industry professionals joined the discussion given their availability.

Within the delegates, 8 participants from 7 countries were given scholarships to attend the Fusion Forum. This helped to broaden the international network of the SGAC and allowed delegates to interact with people from many countries and very different backgrounds. The age range of selected delegates was from 23 to 35. Of all the delegates who attended, 38% were female and 62% male.

The majority (87%) of the attendees were young professionals, with the remaining 13% currently studying at universities across the world. Of the student participants, 67% were Master's students and 33% were Ph.D. students. The young professional attendees came from a variety of space related fields such as aerospace medicine, space law, space policy, engineering, and science. Delegates represented commercial and non-profit organisations, space agencies, and universities..



Representatives of 15 countries participated in the Fusion Forum. The highest percentage of delegates came from the USA, followed by Canada; Participants represented both nations with developed and developing space programmes.

Country of Citizenship	Number of Delegates
Australia	1
Argentina	1
Canada	4
Colombia	1
Ecuador	1
France	1
Germany	3
Greece	1
India	1
Japan	1
Netherlands	1
Spain	1
UK	1
USA	28
Vietnam	1
Total	47

Fusion Forum Delegate Citizenship

The SGAC provided two kinds of scholarships to international university students and young professionals: six Global Grants, and two Washington Space Business Roundtable (WSBR) Scholarships. The grants were awarded to applicants who demonstrated exceptional academic and professional contributions to the global space sector. All actively contributed to the success of the Fusion Forum.

Global Distribution of SGAC Scholarship Awardees

Fusion Forum Scholarship Awardees

First name	Last name	Scholarship	Country of Citizenship
Kate	Becker	SGAC-WSBR	USA
Joyeeta	Chatterjee	Global Grant	India
Ross	Findlay	Global Grant	UK
Alanna	Krolikowski	Global Grant	Canada
Katrina	Laygo	SGAC-WSBR	USA
Yusuke	Muraki	Global Grant	Japan
Pascal	Renten	Global Grant	Germany
Thu	Vu	Global Grant	Vietnam

Fusion Forum Scholarship Awardees

Reactions of Scholarship Awardees

"I'm very happy to be able to participate in Space Generation Fusion Forum thanks to this Global Grant. This will give me a great opportunity to meet next generation of space sector leaders from government, industry, and academia, and exchange our views on current, hot space topics including regional space programs, which is my current interest. I would like to contribute the discussion of the forum by making the most of experiences of working as engineer/flight controller of ISS program and promoter of space technology applications for sustainable development."

Yusuke Muraki, Japan, recipient of the Global Grant Scholarship

Global Grants Awardeeswith the Fusion Forum Manager

"Thank you SGAC and WSBR for recognising me and providing me with this incredible opportunity! I am very honoured to be able to actively participate in Fusion Forum and the National Space Symposium. I look forward to applying my experiences from this opportunity to both my academics and my career aspirations."

Katrina Laygo, USA, recipient of the WSBR SGAC Scholarship

SGAC-WSBR Awardees with WSBR and SGAC representatives. From left: Stephen Ringler, Katrina Laygo, Kate Becker, Andrea Jaime

All sessions are held at the Cheyenne Lodge of the Broadmoor Hotel unless otherwise noted

	SUNDAY, APRIL 7, 2013	MONDAY, APRIL 8, 2013
07:30	Delegate Arrivals	Bus Transportation: Comfort Inn to Cheyenne Lodge
08:00		Panel 1: Long Term Sustainability of Space Moderator: Victoria Samson
09:00		Panel 2: Operational Data Exchange and Sharing of Space Assets Moderator: Richard DalBello
10:00		Keynote Speaker: Johann-Dietrich Wőrner
		Coffee Break
11:00		Panel 3: Innovative Space Exploration Strategies Moderator: A.C. Charania
12:00		Panel 4: Regional Space Programmes: Benefits and Risks Moderator: Norimitsu Kamimori
	Bus Transportation: Comfort Inn to Cheyenne Lodge	
13:00	Registration at Cheyenne Lodge	Fusion Forum Closing Lunch Keynote Speaker: Mark Kinnersley NSS Keynote Speaker: Lon Levin
14:00	Welcome & Opening Keynote Speakers: SGAC & Space Foundation Leaders, Mark Sirangelo (Keynote Speaker)	Closing Remarks, Announcement of the MVP Award and Group Photo
	“Long Term Sustainability of Space” Speaker: Brigadier General Roger W. Teague	Bus Transportation: Cheyenne Lodge to Broadmoor Hotel Main Ballroom
15:00	Coffee Break	New Generation Leadership Exchange (Broadmoor Main Ballroom)
16:00	“Operational Data Exchange and Sharing of Space Assets” Speaker: David Finkleman	
	“Innovative Space Exploration Strategies” Speaker: Leroy Chiao	
17:00	“Regional Space Programmes: Benefits and Risks” Speaker: Carissa Christensen	New Generation Networking Reception (Broadmoor Main Pompeian Room)
18:00	Fusion Forum Opening Reception	Free Time
19:00	Free Time or Optional Social Gathering (Phantom Canyon Brewing Company) Shuttle departs Comfort Inn for Phantom Brewery at 20:00 and returns at 22:30	National Space Symposium Opening Ceremony (International Centre: Main Stage)
20:00		National Space Symposium Opening Reception (Lockheed Martin Exhibit Centre, and Pavilion)

fusion forum organising team

The Fusion Forum would not have been possible without the support of the Fusion Forum team which organised the event.

Name	Country	Position
Andrea Jaime	Spain	SGAC Executive Director
Stephen Ringler	USA	Fusion Forum Manager
Ryan Laird	UK	SGAC Intern
Paul Guthrie	USA	Fusion Forum Program Team Co-Lead
Julio Aprea	Argentina	Fusion Forum Program Team Co-Lead
Emmanuelle David	France	Fusion Forum Program Team Co-Lead
Tiffany Chow	USA	Fusion Forum Delegate Co-Lead and Communications Lead
Kyle Buse	USA	Fusion Forum Delegate Co-Lead
Kristine Ferrone	USA	Fusion Forum Logistics Co-Lead
Emma Hinds	USA	Fusion Forum Logistics Co-Lead
Stephanie Wan	USA	Fusion Forum Special Projects Coordinator
CJ Nwosa	Nigeria	SGAC Chair
Chris A. Vasko	Austria	SGAC Co-Chair
Catherine Doldirina	Georgia	SGAC Former Chair

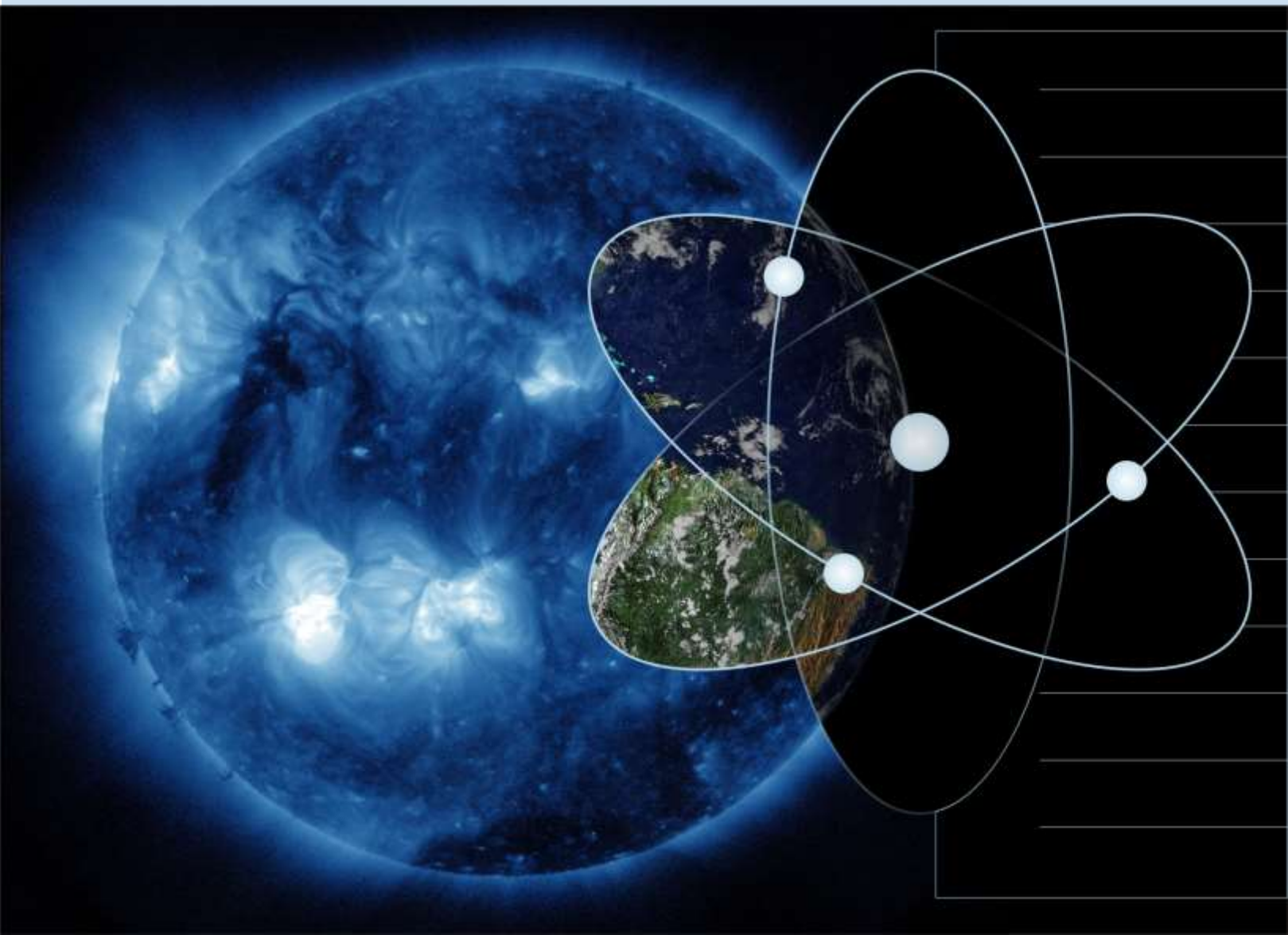
Fusion Forum Organising Team

Additionally, the SGAC would like to extend a special thanks to the Space Foundation team for all of their support in organising the Fusion Forum.

Members of the Fusion Forum organizing team. From left: Julio Aprea, Stephanie Wan, Paul Guthrie, Kyle Buse, Tiffany Chow, Emma Hinds, Kristine Ferrone, Stephen Ringler, and Andrea Jaime

SPACE GENERATION FUSION FORUM PANEL REPORT

Views expressed during the Fusion Forum activities are those of the participants and not necessarily those of the organisations with which they are affiliated.



PANEL 1 – LONG TERM SUSTAINABILITY OF SPACE

Delegates of Panel 1

DELEGATES AND MOEDERATOR

Name*	Nationality	Designation	Affiliation	Country of Residence
Victoria Samson (Moderator)	**USA**	**Washington Office Director**	**Secure World Foundation**	**USA**
Alex Karl	Germany	Operations Engineer	Space Application Services	Belgium
Joyeeta Chatterjee	India	PhD Candidate	Institute of Air and Space Law at McGill University	Canada
Dan Hendrickson	USA	Director of Civil and Commercial Space Systems	Aerospace Industries Association	USA
Justin Kugler	USA	Operations Strategic Analyst	Center for the Advancement of Science in Space	USA

A. Introduction

The last 50 years have seen a significant increase in the usage of space, both in terms of the number of actors (including both public and private entities) and the volume of space assets launched per actor. As the space arena thus becomes crowded, changes are required to ensure its long-term sustainability. Of particular interest is the growth in the number of developing space entities, the increased risk from space debris, and new international norms of responsible behaviour in space.

B. Advice from Space Experts

The panel was supported by an opening speech from Brig. Gen. Roger W. Teague, Director of Strategic Plans, Programs and Analyses at Headquarters Air Force Space Command, Peterson Air Force Base, Colorado.

Brig. Gen. Teague raised the fundamental question of what can be expected in the coming future of the space industry, stating that the best way to answer this is to look at the past for reference. He stated that the global space economy has grown by 37% over the past 5 years, and that despite shrinking public budgets in many parts of the world, the space industry has so far remained robust against these reductions. This is supported by a Compound Annual Growth Rate (CAGR) of national space budgets of between 2% to 9% every year from 2004 to 2011[1] [1]. Many emerging players also continue to strengthen, including South Korea, Singapore and Iran [1], showing that space is still seen as an attractive industry outside of the established players.

Brig. Gen. Teague also discussed that in order to guarantee further sustainability of the international space industry, an additional relaxation of US International Traffic in Arms Regulations (ITAR) is necessary. While certain relaxations have already been announced [2], most of these measures have yet to take place. ITAR, while designed to protect US national security interests, has constrained growth in the US market and has also had significant impacts on the international industry by reducing ease of access to US technologies [1]. With regards to recent sequestration measures in the US [3], Brig. Gen. Teague stated that the key to handling this is to first establish the new limits of any budget, and that once these are established, the planning can be managed.

Finally, in response to a question about what policy the US and its allies should follow with regards to North Korea, Brig. Gen. Teague stated that it was important to ensure that all countries, whether US allies or not, had access to space for peaceful purposes. He clarified this by adding that as soon as any country's activities become non-peaceful, only then should the international community take action to prevent such aggressive acts.

C. Panel Discussions

The *Long Term Sustainability of Space* panel was moderated by Victoria Samson, Washington Office Director, Secure World Foundation. The panel addressed the legal aspects of space debris, the growing problem of radio frequency interference, the impact of emerging space nations on space sustainability, and suggested international norms of responsible behaviour in space.

Legal implications of space debris

The panel opened by discussing the legal implications of space debris.

It was noted that at present, only the principals of due diligence and due regard, as stated in Article 9 of the Outer Space Treaty, apply to space debris: namely, to avoid "harmful contamination" of the space environment [4]. However, Article 9 was not originally framed with regards to space debris, and the generation of space debris does not explicitly remain illegal. Indeed, no international treaties have yet stated what "space debris" constitutes – a soft law definition exists in the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space [5]. However, this is a technical

[1] 2012 data not yet available

definition and did not take account of legal input. Furthermore, it is stated that this definition is to be used only in terms of the document for which it was written.

While no binding international legislature currently exists, various parties have attempted to install practical guidelines into their working practices. The above mentioned [5] is one such example, as is the European Code of Conduct for Space Debris Mitigation [6]. The European Code of Conduct is interesting in that it is binding on all European space-faring nations, and represents a multi-party example of an attempt at guidelines (signatories include ASI, BNSC, CNES, DLR and ESA).

However, there remains no legislative force for ensuring compliance with either of these guidelines. Any such legal framework to be developed would need to cover both obligations and rights. In the panel's opinion, in terms of obligations, it is necessary that the ownership of any object put into space must remain with the original owner even after the end of the operational mission. Hence this owner is liable for any costs incurred due to removal and/or passivation. However, innovative means must be introduced to handle this cost impact without over-constraining competitiveness. One idea from the panel included the levying of launch taxes to create an international mitigation fund that could be used to help cover the cost of space debris mitigation measures in certain circumstances.

Collision avoidance and national security

Beyond the legal implications of space debris ownership, obligations and rights, there remain practical questions about how to limit the growth in space debris and to mitigate the impact of debris already there. There are two major points to this: large, highly-destructive but predictable space debris (i.e. launcher upper stages, expended satellites); and smaller, high-energy debris in the 1 to 5 cm range. For both areas, knowledge is key: the orbital properties of the debris must first be known in order to avoid collisions. For the larger debris, many of these objects are already known and easy to track. However, there remain uncertainties in predictions and some objects' information is withheld for security reasons (e.g. military satellites). Initiatives such as the SOCRATES server (run by the Center for Space Standards and Innovation) [7], provide satellite operators with twice daily predictions on upcoming collisions based on unclassified data from NORAD [8]. However, many satellite operators such as the US military are reluctant to provide data. As such, it is the implicit responsibility of these operators to ensure that their assets stay out of the way of known assets, using all available data and services such as SOCRATES. In contrast, industry groups and commercial operators are in a better state to deliver such information. It was proposed by the panel that a direct interface to the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOUS) [9] would allow these commercial partners to provide their information to the rest of the sector.

For the smaller debris, it is not yet possible to track the positions of debris in the <5cm range. In addition, these objects are very difficult to shield against and can cause significant damage if they come into contact with another asset. Even though this issue has been predicted for a while, little has changed over the last 10 years. Two main areas of improvement were identified by the panel: first, better tracking systems for small objects should be performed. This may be achieved, for instance, using ground-based laser systems. Secondly, through sustainable design practices such as the use of green propellants and dedicated passive re-entry systems, it would make it easier and safer to de-orbit systems from high-value orbits, and thus reduce the risk of space debris.

Emerging space nations

According to the panel, as more nations gain the ability to launch and operate assets in space, it is important to manage expectations and promote the use of space in a sustainable way. It is also important that this obligation is shared equally by all nations, and that established space nations do not exploit heritage as a reason for unsustainable practices. On the other hand, emerging space nations should not seek the unrestricted access that was granted to the early space nations, with little restrictions on sustainability measures. It was deemed necessary to involve such nations in the sustainability debate early on, and to first ensure that the threat to the long-term availability of space is well understood across all actors. From this basis, decisions can be made that do not place any single

nation or group of nations at an unfair advantage. The International Space Station (ISS) was cited as an example where similar issues are handled well between both emerging and established players. In this program, all decisions involve equal input from all members. This ensures that all nations feel the same ownership for any problem and work together for the best commonly acceptable resolution. A similar approach could be extended to the industry as a whole for space sustainability.

Radio frequency interference

A small note was given to the topic of radio frequency interference. While much of the panel discussions centred on the issue of space debris, it was acknowledged that problems with radio frequency interference could be even more significant in future years. While the International Telecommunication Union (ITU) co-ordinates and limits most cases of problems, there exist examples of problems in the frequency overlaps of the European Galileo and Chinese COMPASS projects [10], and of orbital drift induced problems caused by the malfunction of the Intelsat Galaxy 15 spacecraft [11].

D. Conclusions

Space debris and radio-frequency interference pose significant challenges for the space industry. The key aspect to overcoming these issues is in wide-scale cooperation across all international players. According to the panel, such cooperation and involvement in decision-making must include the input of both emerging and established space nations, and legislature must be established to support this. Furthermore, a greater sharing of asset orbital information and improved tracking systems would give better knowledge and thus improved opportunities for collision avoidance, while sustainable design practices can be used to free up the most valuable orbits.

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PANEL 2 – OPERATIONAL DATA EXCHANGE AND SHARING OF SPACE ASSETS

Delegates of Panel 2 with Moderator Richard Dalbello (leftmost)

DELEGATES AND MODERATOR

Name*	Nationality	Designation	Affiliation	Country of Residence
Richard DalBello (Moderator)	**USA**	**Vice President, Government Affairs**	**Intelsat General Corporation**	**USA**
Natassa Antoniou	Greece	Project Manager	Secure World Foundation	Belgium
Michael Brett	Australia	Chief Operating Officer	Aerospace Concepts	Australia
Jon Vince	Canada	Attorney		USA
Thu Vu	Vietnam	Team Lead	F Space Laboratory, FPT University	Vietnam

A. Introduction

GEO and LEO are becoming highly congested orbits due to the growth of the space satellite business, especially for telecommunications and Earth observations. This panel discussed potential threats to the development of this sector of the economy, as well as ways of encouraging the collaboration between governments and industries to exchange and validate their data, or even to share space assets. The panel analysed the current ways of gathering data, spectrum allocation issues, as well as the need for and benefits from a common base for data exchange.

Space is becoming highly congested due to the growth in space activities, and recent events such as the Chinese ASAT test and the collision between Iridium 33 and Cosmos 2251 are a consequence-prove of this. Though orbital debris has yet to manifest as a day-to-day issue, it has potential for exponential growth. Coordination of spectrum usage is also an increasingly important issue as this resource becomes increasingly scarce.

This panel discussed these threats to the development of the space economy, and existing commercial structures (such as the Space Data Association) for mitigating those threats. In particular, the panel focused on secure mechanisms for sharing space data that allow for better management of the space environment. In discussing the mechanisms, panellists brought experiences and expertise in data sharing in many parts of the space industry, discussing the barriers to exchanging technical and competitive data.

B. Advice from Space Experts

The panel was supported by keynote speech entitled “Operational Data Exchange and Sharing of Space Assets” by Dr. David Finkleman, Senior Scientist, Center for Space Standards and Innovation (CSSI), Analytical Graphics, Inc. (AGI).

Dr. Finkleman discussed his view of space as a shared environment by many international actors and noted that there are increasing numbers of newcomers. He insisted that data sharing is essential: everyone must participate for it to benefit everyone, and that anyone who does not participate is a threat to everyone. However, there are political, diplomatic, commercial, scientific and technological issues associated with data sharing.

He then gave the example of the Space Data Association (SDA), a non-profit association that brings together satellite operators who value controlled, reliable and efficient data sharing critical to the safety and integrity of the space environment and the radio frequency (RF) spectrum. The SDA was founded by Inmarsat, Intelsat and SES — three of the leading global satellite communications companies. It is well noted that all participants in SDA are competitors. There is a broad participation of operators in GEO and in LEO, with associate members such as NOAA and NASA.

C. Panel Discussions

The *Operational Data Exchange and Sharing of Space Assets* panel was moderated by Richard DalBello, Vice President, Government Affairs, Intelsat General Corporation. The panel discussed barriers to operational data sharing between international players, some practical examples were discussed and recommendations were given.

Data sharing does not take place at an optimum level today, and there are barriers currently in place preventing more data sharing from occurring, in both the technical and policy realms. At a basic level, data sharing is not required for many missions to succeed, so it is seen as an option rather than a necessity. Additionally, operators often want to keep data for their own use. On the regulatory side, national laws and policy at times restrict the ability to share data. All of these factors lead to there simply not being enough data available to ensure a safe and sustainable space environment, and demonstrate that the role of operators and regulators both need to be examined.

Despite the lower-than-optimal level of data sharing currently occurring, there are examples of efforts in place that are creating an environment more encouraging of data sharing, increasing the amount of data shared, and producing results that are not possible without collaboration. The SDA, discussed by

Dr. Finkleman, is a primary example of several operators choosing to share their own data and creating a mechanism for others to share data as well. Secondly, the SOCRATES server provides a "hit-list" of potential upcoming collisions, demonstrating the analysis that can be done with data that is shared. Finally, the QB50 project, which consists of a network of 50 CubeSats, was developed by 50 international universities for scientific study of the lower thermosphere, where it is impossible for a single entity to carry out such a project. All data collected from the satellite network will be shared among participants. This project is a example of sharing both space assets and ground facilities.

Based on the barriers and examples discussed above, the panel discussed what is needed in the future to improve operational data sharing. First of all, efforts are needed in all realms from the technical to the political. However, as there are already mechanisms available for dealing with technical issues, the greatest need is to conceive of and analyse mitigations for political, diplomatic, and commercial issues. Fundamental to mitigating issues in these areas is creating an environment that is encouraging of data sharing on the international scale. Out of this should come a framework for broad international civil and commercial collaboration. Such a framework will require the use of precise terminology (particularly across the international community) in order to avoid issues. Options for facilitating such a framework are implementing a pay element for sharing data, creating opportunities for public-private partnerships, and encouraging open source approaches to sharing data. A key aspect of this framework will be to have protocols in place in advance of an unexpected event, so that we understand how prepared we are and are not developing practices while at the same time dealing with an event that potentially has significant ramifications.

In addition to the need for an overarching framework, specific requirements exist for each operator. First, operators need to share satellite position data. If an operator does not share this data, it is their responsibility to avoid collisions with other assets and debris. In addition to positional data, orbital analysis should also be shared. Actionability is a must for information that is shared, and data assurance, integrity and security are paramount. Specific cases provide interesting questions that should be examined, such as the question of who has responsibility in the case of "zombie satellites". Neutrality among participants from different nations and jurisdictions is critical to all of these actions.

Finally, it was noted that SGAC members can specifically contribute to mitigating issues in the realm of operational data sharing by developing political and programmatic solutions to the problems stated above.

Following the panel presentations, there was good discussion with delegates in the audience on practical needs and guiding principles. On the practical side, if operators do not want to share data, it is their duty to stay out of others' way. Space weather was discussed as a factor, in that we cannot predict well enough where satellites are in advance because of natural phenomenon that occur on small time scales. Finally, going back to where a conjunction was believed to have taken place and looking at what actually happened can provide valuable insight. Discussion concluded with a big picture discussion of motivations for collaboration in data sharing. If everyone looks out only for themselves, everyone will lose. Ideas of game theory can be applied, and in fact lawyers are using game theory to solve problems in this area.

D. Conclusions

Operational Data Exchange and Sharing of Space Assets are important for the future of space activities, as it brings benefits to all participants in a shared operating environment of space. It helps to create an environment for collaboration among countries and builds trust among participants. This is especially important for new players. However, there are some barriers that need to be addressed, particularly in the areas of law and policy. There are some existing mechanisms and examples that can be referenced, and SGAC can contribute by assisting with political, programmatic solutions to stated problems.

PANEL 3 – INNOVATIVE SPACE EXPLORATION STRATEGIES

Delegates of Panel 3 with Moderator AC Charania (leftmost)

DELEGATES AND MODERATOR

Name*	Nationality	Designation	Affiliation	Country of Residence
A.C. Charania (Moderator)	**USA**	**Business Development Manager**	**Virgin Galactic**	**USA**
Sirisha Bandla	USA	Assistant Director	Commercial Spaceflight Federation	USA
Ross Findlay	United Kingdom	System Engineer	German Aerospace Center (DLR)	Germany
Pascal Renten	Germany	Young Graduate Trainee	ESA	Germany
Kris Lehnhardt	Canada	Attending Physician and Assistant Professor	George Washington University	USA
Samantha Marquart	USA	Graduate Student	George Washington University Space Policy Institute	USA

A. Introduction

The commercialisation of the space sector is now a reality. Current and emerging players are getting more involved in exploration programmes for profit, such as asteroid mining and the colonisation of Mars. This panel discussed the social, technological, and economic benefits and pitfalls of commercialising exploration, the development and growth of new markets, and the ethical implications of commercialising space exploration.

B. Advice from Space Experts

The panel benefited from the insights of Dr. Leroy Chiao, special advisor for human spaceflight to the Space Foundation.

Dr. Chiao related his experiences as a four-time astronaut and discussed the role of human spaceflight programs in preparing for future exploration missions. Dr. Chiao flew three Space Shuttle missions, including STS-65 Columbia in 1994, STS-72 Endeavour in 1996 and STS-92 Discovery in 2000. He also flew as first Flight Engineer aboard the Soyuz TMA-5, and served as commander and NASA science officer aboard the International Space Station (ISS) during Expedition 10. These experiences afford him unique insights into how current space activities aboard the ISS are laying the foundations of future exploration.

Having prepared for flight on the Russian Soyuz, Dr. Chiao discussed the demands of this work and shared his impressions of international collaboration on the space station. He recalled the significant progress he and his colleagues made in overcoming intercultural obstacles to cooperation. He noted that maintaining these relationships and learning from these processes will be critical to future large-scale multinational missions.

The important contributions that today's activities aboard the ISS are making for tomorrow's exploration missions were a key point for Dr. Chao. In particular, he discussed the knowledge that scientists and engineers are gleaning about human performance and health on long-duration space missions from astronauts' stays on the ISS. Dr. Chiao explained his work with a U.S.-based organisation dedicated to collecting biomedical data about human spaceflight.

Dr. Chiao predicted that achieving full utilisation of the ISS as an in-space laboratory will be essential to securing long-term public and political support for human spaceflight activities, including human exploration missions. He also explained that joining international partnerships helps individual national governments sustain their commitment to long and costly space missions that often show results only after many years of public investment. From his perspective, national strategic interests and political demands drove the major space programs of the past, such as Apollo. He predicts that political factors will remain important determinants of future space endeavours.

Finally, Dr. Chiao emphasised that the ambitious exploration missions of the future, in particular to ambitious destinations such as Mars, are likely to take the form of international partnerships. Such demanding projects will require established space partners, such as NASA, ESA, and Roscosmos, to include new and/or non-traditional collaborators, including agencies of new space faring nations and commercial actors.

C. Panel Discussions

The panel's discussion was moderated by A.C. Charania, Business Development Manager at Virgin Galactic. Among the topics that panellists addressed were: the means to overcome the technical and institutional barriers to large-scale exploration activities; opportunities for future exploration missions presented by current commercial and agency-led space activities; and new proposals and trends that promise to foster the innovative exploration activities of the future.

Overcoming technical and institutional barriers to space exploration activities

The panellists shared their thoughts on the major challenges facing advocates of missions to new destinations, such as Mars or asteroids, and the means to overcome them.

Speakers observed that a major impediment to large-scale future missions will be the space sector's emerging credibility gap. The taxpaying public is losing confidence in the space community's ability to responsibly manage programs and use public money. Space advocates have too often misrepresented the costs and risks of their projects. The panellists observed that budgets for ambitious missions, such as a human mission to Mars, exist, because space agencies have shown themselves able to collaborate on far costlier endeavours, such as building and operating the ISS.

For the public to support exploration missions in the future, the space community must be realistic and candid about the costs, risks, trade-offs, and actual benefits of these activities. Public support for large missions would be more forthcoming if the goals of space missions were clearly defined and understood.

Institutional, policy-related, and cultural factors also hinder innovative space exploration. The panellists noted that commercial space firms are among the most promising contributors to future exploration missions. However, whether new commercial space actors survive and expand into exploration will depend on the policy and regulatory landscapes they face. Policies and regulatory frameworks can either act as catalysts for new commercial industries that support exploration or they can burden and even overwhelm these nascent businesses and markets.

Panellists noted that innovative exploration efforts are most likely to succeed if hindering institutional legacies and out-dated corporate and institutional cultures are transformed. Relations between industry and government actors must change in order for the space sector to grow and evolve, they said. For example, panellists recommended acquisition reform within the United States and the development of codes of conduct and rules for the safe use of space in international fora. Entrenched governmental and bureaucratic preferences and industry habits pose obstacles to young, entrepreneurially-minded space professionals who want to pursue innovative space exploration ideas.

Beyond budgetary, political, and institutional barriers, innovative exploration projects must also overcome significant technical challenges. For major new human exploration missions, the greatest of these technical challenges lie not in developing new vehicles or propulsion systems, but rather in sustaining astronauts' health and performance during long stays in deep space, observed the panellists. At present, very little is known about how the human body performs and changes over extended periods and while travelling vast distances in this hostile environment. The most important questions and risks for human health and wellbeing centre on the effects of radiation, psychiatric health, reproductive health, and the loss of bone and muscle mass.

In the entire history of the space age, only 24 people have flown beyond LEO, so these phenomena remain poorly understood. The panel explained that hundreds of questions about human health and performance in space need answering before a human mission to a destination such as Mars.

Leveraging current space activities for future exploration missions

The panel noted that commercial firms hold promise with routine and affordable access to LEO, and may someday offer access to more distant destinations at low costs. Whether commercial space transportation capabilities translate into new exploration activities will depend on what other actors do with the opportunities and access that commercial firms provide. Just as the effects of the mobile phone could not have been imagined at its inception, so too the implications of low-cost access to space are impossible to predict today, the panel reasoned. The development of space applications that are commercially viable will be an important shaper of the commercial space transportation industry.

The panel also agreed that the ISS offers unique opportunities to prepare for future exploration missions. The ISS is a platform for such activities, offering commercial partners a setting in which to develop technologies needed for exploration. The ISS also makes possible biomedical work in support of future missions. Panellists agreed that more activities of this type and missions to destinations such as L1 or L2 remain preconditions to a human mission to Mars.

Innovative proposals and emerging trends fostering exploration activities

Panellists identified new ideas and developments holding the greatest promise of supporting innovative exploration efforts in the future. Among these were: the maturation of commercial space, including the development of commercial crew transportation and NASA's turn to human missions beyond LEO; the coming drop in launch costs that currently limit exploration missions; the prospect of civilian travel to space and the expansion of access to space to the general public; and change and turnover in the space workforce over the coming decade.

The panellists also discussed the prospects and potential of privately initiated human missions to Mars, such as the recently announced MarsOne and Inspiration Mars projects. While all the panellists agreed that these missions were exciting and that they drew public attention to exploration in unprecedented ways, they also shared their scepticism about the readiness of the technology proposed for these missions and noted other challenges to these projects.

D. Conclusions

While humanity's exploration of space seems to have stalled since the Apollo lunar landings of over four decades ago, today there exist more diverse pathways for us to explore space than ever before. This panel noted that significant institutional, political, and technical obstacles to large-scale exploration missions persist, but also proposed means to overcome these challenges. Moreover, this panel drew attention to important new trends and technologies that present actors, both established and emerging, encounter with unprecedented opportunities to discover and expand humanity's reach into space.

PANEL 4 – REGIONAL SPACE PROGRAMMES: BENEFITS AND RISKS

Delegates of Panel 3 with Moderator Norimitsu Kamimori (leftmost)

DELEGATES AND MODERATOR

Name*	Nationality	Designation	Affiliation	Country of Residence
Norimitsu Kamimori (Moderator)	**Japan**	**Washington Office Director**	**JAXA**	**USA**
Alanna Krolikowski	Canada	PhD Candidate	University of Toronto	USA
Yusuke Muraki	Japan	Engineer	JAXA	Japan
Tilo Kauerhoff	Germany	Young Graduate Trainee	ESA	USA
Lewis Groswald	USA	Research Associate	Space Studies Board, National Academy of Sciences	USA

A. Introduction

The era of national competitiveness may be waning with a shift towards the focus of regional space programmes. In particular, emerging countries in regions where the space sector is rather new, such as the Asia-Pacific, are becoming more influential. This panel discussed the benefits and risks of having regional versus national space programmes, the need of new international space policies and laws, and the ways in which competitiveness versus collaboration can influence the future of the concept of global space activities.

B. Advice from Space Experts

The panel was supported by a keynote speech entitled “Government Space Programs by Region” by Ms. Carissa Christensen, Managing Partner at The Tauri Group.

Ms. Christensen introduced an overview of nine regions, U.S. and Canada, Russia/Ukraine/Central Asia, Europe, Latin America, Africa, Asia-Pacific, South Asia, China, and the Middle East. She introduced important numbers regarding space faring nations in each region, such as number of satellites, number of launches, and government budgets.

She pointed out interesting characteristics of each region that can be inferred from these numbers. The US military/intelligence space budget is around half of global space spending. European regional space programs through the European Space Agency (ESA) and the European Union (EU) are iconic in regional space cooperation. Latin America lacks a dominant player. Africa has mostly focused on practical applications with additional interests in international cooperation.

Ms Christensen categorised the Asia-Pacific region as the group of countries including Japan, Australia, Indonesia, Thailand, Malaysia, South Korea, and Taiwan as separate from South-Asia, which consisted of India and Pakistan. China was categorized as an independent region, based on relationship dynamics, size of budget, capabilities and ability to work with partners.

In response to the question about which types of countries make the best partners in space and the possibility of great partnerships between countries of different continents, she introduced the case of China’s partnerships with Venezuela and Nigeria. Ms. Christensen shared that matchmaking beyond a region is a great idea, and that what will make this happen is an environment where there is a political and market momentum, and individuals with the will to do it.

C. Panel Discussions

The *Regional Space Programme* panel was moderated by Norimitsu Kamimori, Director of Washington Office, Japan Aerospace Exploration Agency (JAXA). The panel discussed the advantages and disadvantages of regional space programs, regional space programmes in Europe as a best practice, and of those in Asia and the Pacific.

Advantages and Disadvantages of Regional Space Programme

The panel discussed the advantages and disadvantages of having a regional space programme compared with pursuing space activities by each country alone. The benefits for developed countries are (i) the sharing of costs and (ii) the increase of friendship or influences on partner countries. For small countries, they are (iii) the opportunity to join projects that a small country cannot afford, and (iv) technology transfer from developed countries. On the other hand, disadvantages or risks are (i) the loss of autonomous development, (ii) risk for outflow or leakage of technology, (iii) the risk to lose relative superiority in technology to other country, and (iv) hardship to gain the understanding of tax payers to work with unfriendly countries. If the region is stable enough without political costs for cooperation, regional space cooperation can be achieved for the benefits described above. However, if political interests of countries in a region are different enough for the disadvantages to exceed the advantages, it is difficult to promote such collaboration.

Regional Space Programme in Europe

The panel discussed Europe as an example of a successful regional space programme. There are two players in Europe for the regional space programme: the European Space Agency (ESA) and the European Union (EU). ESA is originally from two different organisations – the European Space Research Organisation (ESRO) for scientific cooperation and the European Launcher Development Organisation (ELDO) for the cooperation in rocket development.

Based on the experiences of regional cooperation through these two organisations, ESA introduced an effective mechanism that realizes benefits for the participating countries. Participating countries of ESA can decide which programme or project they will join. ESA is also based on a fair return (juste retour) policy, in which each country can decide the amount of investment for each project, with companies in the country being contracted based on the amount of the budget of the respective country. Due to these systems, small countries in the region with little to no space technologies can participate in larger projects and begin technology development. In the science field, ESA has a different system in that member countries need to provide a budget based on GDP to secure a budget for science missions that are not directly related to industry. The EU is another player in Europe, managing the Galileo and the Global Monitoring for Environment and Security (GMES) projects.

Regional Space Programme in Asia and the Pacific

The panel discussed the current regional space programmes in Asia and the Pacific. Regional space cooperation exists in the Asia-Pacific region mainly through two organisations: The Asia-Pacific Regional Space Agency Forum (APRSAF) and the Asia-Pacific Space Cooperation Organisation (APSCO).

APRSAF is a forum to share information and discuss topics. It is a venue to exchange opinions and information among participating agencies. APRSAF is not a collaborative research and development organisation like ESA. Additionally, some initiatives such as Sentinel Asia and the SAFE initiative have been started, led mainly by Japan. Challenges remain with this format, as it is not suitable to implement collaborative space projects under this framework. It would be difficult to promote technology transfer from space-developed countries, or cost sharing for implementing projects. This type of collaboration is different from ESA and good for the Asia and Pacific region, because it can avoid touching complicated political issues.

APSCO is a union of space agencies and is more similar to ESA than APRSAF. This framework is led by China and includes Bangladesh, Iran, Mongolia, Pakistan, Peru, and Thailand. This union has primarily targeted technology transfer from China to the developing countries through space project implementation. There is still room to overcome challenges, because the number of countries is limited and because APSCO has not implemented actual projects yet.

The panel also discussed regions that could have the possibility of having a regional space agency like ESA in the future. The most critical reason why it is difficult to have such a regional agency is that dissimilarity in political backgrounds within the region prevents countries from realizing their national interests through regional space projects. As space technology is closely related to national security, it is difficult for each country to collaborate through a regional space agency, unless countries have relatively common national interests. One of risks to being a part of a regional space agency or of international cooperation in the space field is the outflow or leaking of technology, which can be diverted to military use. Countries such as China, India and Japan who are in a position to lead space activities in a region have sometimes been in political tension over disputed boundary or island issues. Additionally, developing countries in the region do not have the financial and technological capacity to pursue space science. Most developing countries in Asia want to focus more on the practical uses of space for the purposes of national security or as a means to build social infrastructure. If countries want to utilize space assets for national security, collaboration through a regional space agency would not be an ideal method, as regional space agencies exist mainly for non-military peaceful uses, and countries would potentially want autonomy in national security programs.

D. Conclusions

Regional Space Programmes are important for the future of space activities, which have been facing severe budget cuts, and for the increase in access to space by emerging countries that do not have the budget to solely maintain a space programme. The European case is a good example of how a regional space programme can benefit member countries. However, there are also risks and disadvantages of such a regional space programme in other regions such as Asia and the Pacific. In order to identify a realistic form of a regional space programme, we need to learn not only the benefits and risks from the viewpoint of space activities, but also of the national and international politics of the region.

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