



INTERNATIONAL
ASTRONAUTICAL
FEDERATION

IAF HIGHLIGHTS

2017



Connecting @ll Space People



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Welcome Message



IAF 2017 Events Overview

Another year has passed and following on our initiative from 2016, we have compiled our main highlights of the year for you to enjoy in this publication, IAF Highlights 2017. This has indeed been a memorable year for the International Astronautical Federation, with conferences organized in places such as Paris, Beijing and Adelaide. A strong emphasis in 2017 has been on space exploration, this was the theme of our Global Conference but has also been a focus in our other events. Especially topics such as the exploration of the Moon and Mars have received a lot of attention, but more notably a strong focus has been on the International cooperation in exploring space and how we can achieve goals together.

Our Global Space Exploration Conference, GLEX 2017, was held in China and co-organized together with our colleagues from the Chinese Society of Astronautics (CSA). It was a great success and followed up the previous GLEX conference held in Washington D.C in 2012. More than 1,000 delegates from 50 different countries gathered in Beijing for a few days to discuss important topics related to Space Exploration. Highlights of this conference

were the welcome speech of the China's Vice President at the Opening Ceremony, Buzz Aldrin's keynote on Cycling Pathways to Mars and many outstanding presentations from top-level speakers from all around the world.

The International Astronautical Congress 2017 took place in Adelaide, Australia. This 68th IAC was organized together with the Space Industry Association of Australia (SIAA) on the theme "Unlocking imagination, fostering innovation and strengthening security". The congress was attended by 4,472 delegates and among all the events there was an extraordinary technical programme and numerous exciting plenaries and GNF sessions, including talks by outstanding personalities such as Bill Nye, Charles Bolden and Elon Musk.

We hope you will enjoy this publication on our main highlights of 2017. We would like to thank all of you who are part of the IAF community, all IAF volunteers and all delegates attending our events. You were all part of making this such a great year and we look forward to another fantastic IAF-year with all of you in 2018!

Jean-Yves Le Gall

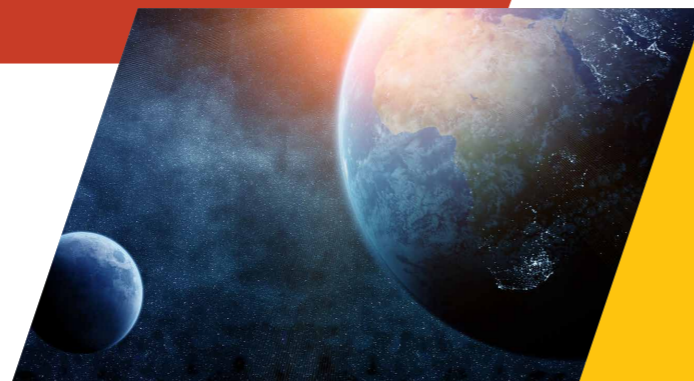
President,
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IAF General Assembly



The General Assembly of the International Astronautical Federation has gathered during the International Astronautical Congress, IAC 2017 in Adelaide, Australia in two sessions (Monday, 25 September 2017, and Friday, 29 September 2017). Several important decisions have been taken.

2017 Elections of IAF Officers

4 new Vice-Presidents have been elected by the General Assembly:



- **Gabriella ARRIGO**, Head of International Relations, Italian Space Agency (ASI), Italy, has been appointed as IAF VP for Science & Academic Relations and Global Networking Forum



- **Seishiro KIBE**, Advisor, Japan Aerospace Exploration Agency (JAXA), Japan, has been appointed as IAF VP for Honours and Awards



- **Valanathan MUNSAMI**, CEO, South African National Space Agency (SANSA), South Africa, has been appointed as IAF VP for Developing Countries and Emerging Nations



- **Baohua YANG**, Vice President, Chinese Society of Astronautics (CSA) and China Aerospace Science and Technology Corporation (CAST), China, has been appointed as IAF VP for Societies and Museums

Selection of Host City for IAC 2020

The IAF General Assembly at its second session on September 29, selected Dubai, UAE, as Host City for IAC 2020. The Hosting Organization is the Mohammed Bin Rashid Space Centre (MBRSC), a member of IAF since 2012.

Upcoming IAF Events

During the IAF General Assembly sessions, reports were given on the advancement of preparation for the IAC 2018 in Bremen, Germany and for the IAC 2019 in Washington D.C., United States.

Also, a detailed presentation was offered on the progress made in the organization of the Global Space Applications Conference 2018 (GLAC 2018) that will take place in Montevideo, Uruguay, from 21-23 May 2018 in cooperation with the Centro de Investigación y Difusión Aeronáutico Espacial (CIDA-E).

The IAF General Assembly has also endorsed the potential organization of a Global Conference on Space for Emerging Countries in 2019 (GLEC 2019). The International Astronautical Federation (IAF) and the Royal Centre for Remote Sensing (CRTS) will be co-organizing the event in Morocco.

IAF Finance

The IAF has also approved the **final accounts 2016 and auditor's statement 2016** and the **revised budget and preliminary accounts 2017** and the **proposed budget 2018**.

New IAF Members

The IAF General Assembly also approved the applications of 21 new Member Organizations from 15 countries worldwide. With this, the IAF Membership comprises 343 Member Organizations from 68 countries, confirming IAF's position as a truly global Federation.

Company	Category	Region	Country
ArianeGroup SAS	Industry	Europe	France
Axiom Space LLC	Industry	North America	United Kingdom
beSpace GmbH	Industry	Europe	Germany
Center for Innovation in Aerospace Technology (CINAE)	R&D	Europe	Spain
EOS Data Analytics	Industry	North America	United States
Incomspace	Industry	Latin America	Mexico
Instituto Tecnológico de Costa Rica (TEC)	University	Latin America	Costa Rica
ispace, inc	Industry	Asia	Japan
New Zealand Space Agency	Space Agencies & Offices	Oceania	New Zealand
Planet Labs	Industry	Europe	The Netherlands
PRatian LLC	R&D	North America	Puerto Rico
PwC Advisory	Industry	Europe	France
Singapore Space and Technology Association (SSTA)	Association & Professional Societies	Asia	Singapore
Sky and Space Global (UK) Ltd	Industry	Europe	United Kingdom
Space Cooperative Inc	Association & Professional Societies	North America	United States
Space Environment Research Centre Limited	R&D	Oceania	Australia
Space Tech Expo - Smarter Shows Ltd	Industry	Europe	United Kingdom
Spacety	Industry	Asia	China
Swiss Space Office SSO	Space Agencies & Offices	Europe	Switzerland
The University of Sydney	University	Oceania	Australia
Viterbi School of Engineering	University	North America	United States

IAF Symposium 2017

IAF Symposium at UN COPUOS STSC in Vienna (8 February):
What is at Stake in Space in 2017 and 2018?



Recent years have seen a dramatic shift in the way humanity conducts space activities. Nicknamed Space 4.0, the space activities, space participants, and the impact of space has expanded from previously being the sole activity of a few space agencies to being a global endeavour of academia, industry, governments, and the public. Activities in space have had many wide-reaching benefits, however there must be international collaboration to ensure the ongoing access to space by all.

Human space use has dramatically changed in the decade. What was once the sole field of government agencies has now given way to the commercialisation of space, with private companies having the capability to launch spacecraft to extra-terrestrial bodies, building space stations, or construct satellite constellations. Jan Woerner of ESA discussed the role that governmental space agencies have started to take, and should continue to take to adapt to the new environment; becoming facilitators of space activities rather than solely conducting the ground-up manufacturing of spacecraft and conducting research of space. Jan discussed the importance of global involvement on research; where, if the entire space community is part of a scientific research study, its results are far more likely to get global agreement. Furthermore, space programmes such as

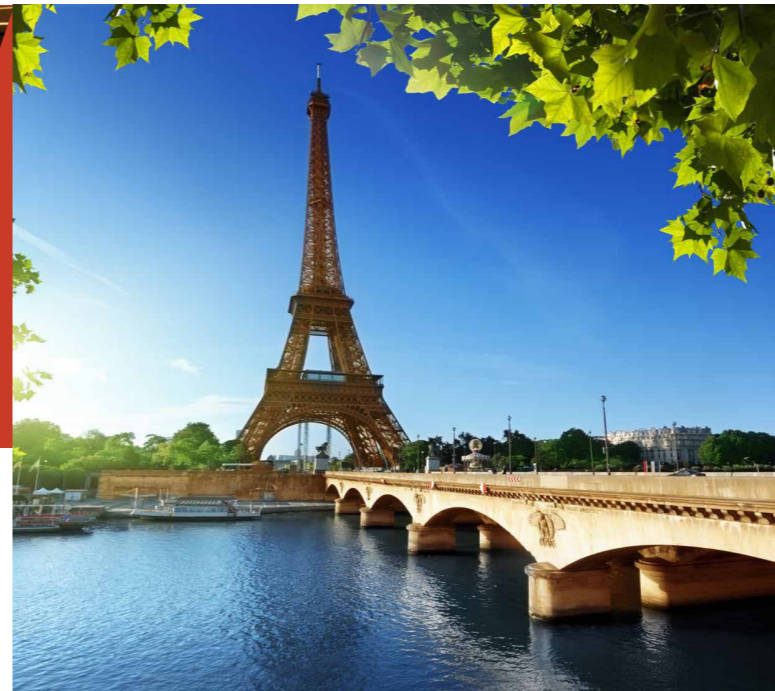
the International Space Station, are a testament to what is achievable by humanity when we all work together.

Not only is there a need for communication between space agencies and space industries, there is a definite need to make all of humanity aware of the benefits of space. Sandy Magnus of the AIAA discussed the need to have clear communication with the public of the existing and future space activities, especially of the reason why we do go to space. This is especially important with politicians and investors to ensure stability and continuity of existing space programmes despite domestic and international politics.

The access to space has many direct benefits. Ground observation can provide information on the weather, ground fires, and the impacts of climate change on Earth's environment to name a few. The use of the internet from satellites has had lasting impacts in remote locations by connecting people from around the globe, enabling the sharing of medical expertise, improving education, and allowing effective distribution of food, water and other resources to where they are most needed. Future projects, such as the OneWeb satellite constellation planned to launch in 2018, are set to further improve the global impacts of space.

As the number and breath of space activities increase, there is an increasing need for strategies to ensure that space can be sustainably shared amongst all parties. Issues such as space debris and safe disposal strategies of satellites can drastically affect how much of space is available for use. As IAF Symposium Chair John Horack and many of the panel members said, space is intrinsically a global endeavour, and as such, there must be international collaboration to ensure the ongoing preservation of space for all.

IAF Spring Meetings 2017



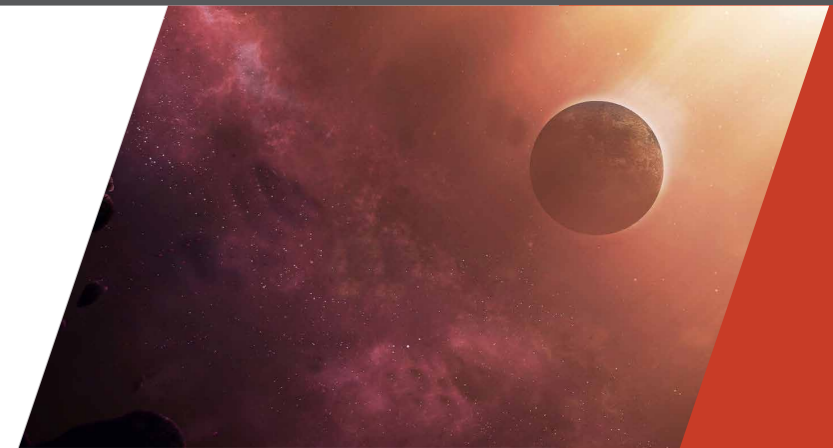
On 21 – 23 March the IAF hosted its traditional **Spring Meetings 2017** in Paris. Various events took place during the SM including the selection of abstracts for IAC 2017; an IAF Diversity Day, comprising of an IDEA 3G Diversity Breakfast, Luncheon and Afterwork gathering; committees' meetings including 2 sessions of the IAF Bureau; Global Networking Forum sessions on various topics such as the "Outcome of the ESA Council Meeting at Ministerial Level", "A Step by Step Approach to Low-cost Access to Space" by Blue Origin, "The OG Summit - Shuttle Diplomacy in a New Space Age" by Space Trust and "Proxima Mission Presentation" and, of course, the traditional IAF cocktail.



IAF Global Conferences

GLEX 2017

Global Space Exploration Conference 2017, Beijing



IAF Committee Meetings



IAF Distinguished Service Award Ceremony



IPC General Meeting



IAC 2017 Abstract Selection



IAC 2017 Abstract Selection



IAF Spring Meetings

The sixth instalment of the IAF Global Series Conferences, the Global Space Exploration Conference 2017 (GLEX2017) took place at the Beijing International Convention Center on 6-8 June 2017 and it was a great international success, with a participation of over 1,000 delegates from more than 50 countries.

The Conference was co-organized by the IAF and the Chinese Society of Astronautics (CSA), a close member of the Federation since 1980, the host organization of two outstanding International Astronautical Congresses (IAC 1996 and IAC 2013), the host organization of the successful 2010 Global Lunar Conference (GLUC) and an IAF Alliance Partner.

GLEX2017 brought together leaders and decision-makers within the science and human exploration community – engineers, scientists, entrepreneurs, educators, agency representatives and policy makers.

The Plenary Programme showcased four Plenary Events, including a Heads of Agencies plenary, a session on the Development of China Space Activities and a session on the Importance of International Cooperation. In addition, 9 top-level Keynote Lectures touched upon a series of high-level topics, including presentations from the European Space Agency Director General, the Former Apollo 11 Astronaut, Buzz Aldrin and on China Space Exploration Missions.



IAC 2017

The IAF Global Networking Forum Programme touched upon the most recent and hot topics in Space Exploration with a total of 9 sessions, giving all participants the opportunity to be updated on recent developments and future endeavors in Space Exploration.

The Technical Programme for GLEX2017 was organized in special sessions which were divided into 25 tracks covering all aspects of space technology. The programme involved authors from 22 countries. It was composed by 200 high-quality papers and 50 posters that have been thoroughly reviewed and selected out of 392 submissions. The most popular session, in terms of attendance, was Session 3 on Lunar Exploration with more than 100 participants. Altogether, the technical sessions attracted daily 500 participants.

In the frame of the IAF International Platform for Diversity and Equality in Astronautics (IDEA) a "3G" Diversity lunch was hosted jointly by IAF and CSA.

The Pre- and Post-Congress activities, such as the SpaceUp, the International Lunar Observatory Association Galaxy Forum and the Technical Visits were extremely well-attended and contributed to the success of the whole Conference.

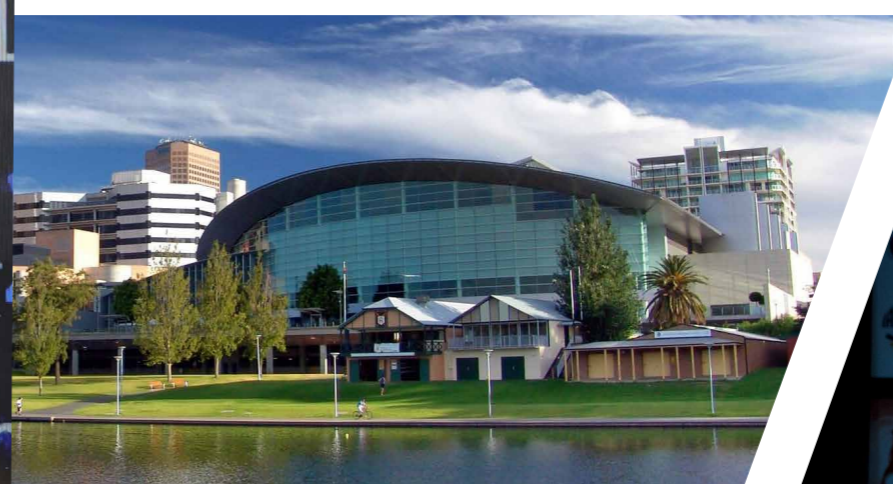
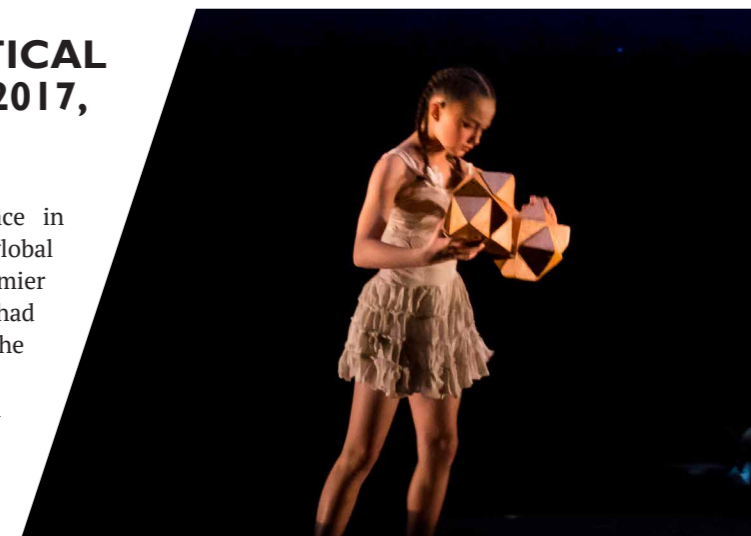


OVERVIEW

INTERNATIONAL ASTRONAUTICAL CONGRESS, 25-29 SEPTEMBER 2017, ADELAIDE

The 68th International Astronautical Congress took place in Adelaide, Australia last September with more than **4,400** global delegates from 72 different countries. IAC is the world's premier space event and it keeps growing from year to year. IAC 2017 had the most packed programme we have ever featured. Some of the main highlights included:

- Bill Nye "The Science Guy" recounted the inspiring story of the Lightsail® solar sailing spacecraft.
- Charles Bolden, our 2017 IAF World Space Awardee, gave an excellent Highlight Lecture on how to grow opportunities for international cooperation in science and astronautics.
- Lockheed Martin spoke about the Mars Base Camp and the Deep Space Gateway projects.
- And for the second time, following on from the previous IAC in Guadalajara, Elon Musk from SpaceX presented an update on his plans for colonizing Mars.

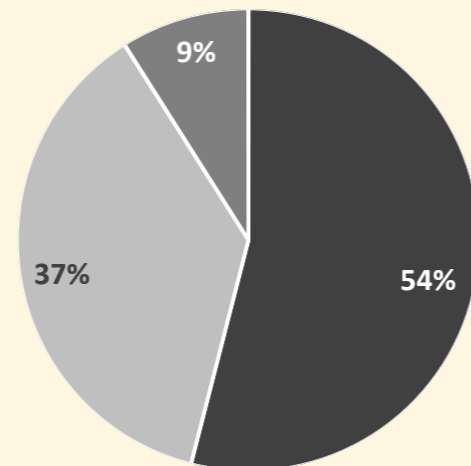


IAC 2017 Plenaries

- 8 Plenaries
- 3 Highlight Lectures
- 180 Technical Sessions
- 42 GNF Events
- 1,700 Technical Papers
- 2 Late Breaking News
- 280 Interactive Presentations
- More than 60 Exhibitors
- 7 Press Conferences

Age groups attending the IAC 2017

- 54% <35 years
- 37% 35-60 years
- 9% >60 years



Plenary I: Heads of Agencies

The nature of human space activities has dramatically changed over the past years, with exponential growth in the number and type of participants. The role of the space agencies in supporting science and business stake holders to engage in space activities was discussed in the Heads of Agencies plenary session on Monday 25 September.

A common view amongst all the agency heads was the mutually complementing nature of business and science. The President of the Japanese Aerospace Exploration Agency (JAXA), Naoki Okumura, expressed this as “developing both [science and business] provides a benefit to humanity”. Early human space activity was driven by exploration and discovery, however with the rise of new space technologies and increased commercialisation, space activities – particularly for space agencies – have significantly advanced the frontiers for state of the art sciences as well as created new opportunities in business development. Space activities can now benefit all aspects of human life; ranging from energy, water and food security, to disaster management and earth observation.

Robert Lightfoot, NASA Acting-Administrator, told the plenary session that a common misconception of space agencies is the belief that they should either promote business activities before science, or science before business. The value of conducting science missions such as the recently disposed Cassini-Huygens probe to Saturn may not be easily seen, but these missions have the ability of engaging with everyone. This was built on by Jan Woerner, the Director General of the European Space Agency (ESA), who discussed the ability of space to inspire and fascinate people, especially the younger generation. The benefit of this cannot be measured, and as such, must be made known to those in a position to fund space activities.

The interlinked nature of science and business may be far closer than what at first appears, reported the President of the Canadian Space Agency, Sylvain Laporte. What may at first seem only as exploration missions to conduct science, may in the future prove to have massive unforeseen benefits. One such example mentioned by Igor Komarov, Head of ROSCOSMOS, is the launch of Sputnik around 60 years ago, which paved the way for modern telecommunications and business. Komarov continued by stating that many other research activities currently being conducted may have unforeseen applications or functions in the future. To support continued groundbreaking innovation, we must ensure different disciplines, generations, cultures and countries are included. The space industry, as both a consumer and a creator of disruptive technology, is in a key position to lead this.

What are the big growth areas in space? Both Laporte and Tian Yulong, Secretary General of the China National Space Administration, discussed how the growing demand for data is one of the current growth areas for space, especially with the ever increasing number of Earth observation satellites. This data can provide fantastic benefits to downstream users, and its use is not restricted to government organizations. To ensure ongoing benefits to all of society, space agencies



must provide leadership on facilitating availability of data for all.

The plenary also discussed the role of space agencies in providing incubation for new space technology. The Director of the Liquid Propulsion Systems Centre in India, Shri Somanath, highlighted that while there has been a shift from space agencies to private companies conducting space activities, a lot of these activities are still in their early stages of development. Space agencies should continue driving technology innovation by

providing funding or incubation of new businesses, leaving the technological commercialisation of space to the private sector.

Common amongst all plenary's panellists was the desire for increased future collaboration, especially with the announcement of the Australian Space Agency earlier in the day. The panellists discussed their agencies' plans for extra-terrestrial exploration, not as individual countries, but as a united world. Through space activities such as this, we will inspire the next generation on Earth.

Plenary 2: The Space Industry's Economic and Social Impact - Host Plenary

The IAC host plenary discussed the role and value of a space agency on the global stage, with a focus on the future direction of the Australian Space Agency, the formation of which had been announced earlier that morning.

Australia already has a large space industry, with around \$3 billion AUD in annual revenue and a workforce of between 9,500 to 11,500 people. Space industry data uses include weather forecasting, disaster management, health, precision agriculture and environmental monitoring. However, as discussed by the Chair of the Space Industry Association of Australia, Michael Davis, much more can be done. Davis described his vision of having a mature and self-sustaining Australian space industry that conducts high-tech and innovative research and development. A national space agency would be able to deliver leadership within this space industry, being able to drive innovation in areas that provide direct benefits to the Australian public.

But how can Australia build a successful space sector? For Brian Schmidt, Vice-Chancellor of the Australian National University, a successful space sector requires people with the right training and experience, a focus on solving real-world issues for Australia, and a critical mass of space companies and organizations. While Australia has had the former two key items for some time, Schmidt stated that only in recent years has the space sector started to coalesce from separate fragmented areas of activities. This was built on by Lisa

Callahan, the Vice-President and General Manager of Civil Space at Lockheed Martin, who stated that while trying to develop self-sustaining space activities from a critical mass of space organizations is a good focus, we should not overlook the need to collaborate with other companies and organizations across the globe. We may need to bring in expertise from elsewhere, if the required knowledge or experience does not exist in Australia. This sentiment was echoed by Mohammed Al Ahbabi, Director General of the UAE Space Agency, who stated that since their establishment in 2014, their international collaboration has been key to the agency's ongoing success on the global stage.

Another key item for a successful space sector is the need to discuss the benefits of space to those who are unaware of its benefits. Space already has had wide-ranging benefits for our society. This will increase even more in the future. Madis Vooras, Head of the Estonian Space Office discussed how this is not something that should be solely undertaken by a space agency, but instead of all those involved in the space sector. We must also be sure to explain it in easily understandable terms and directly applicable uses. In doing so, we can support the integration of space activities within the school system, and inspire young people to become involved in STEM education areas.



Safeguarding a safe space environment is critical in the increasingly congested space domain, the third plenary session was told. Not only do satellite operators need space situational awareness of their assets to ensure they do not infringe on other satellites, there is an increasing amount of orbital debris which poses a safety risk to all satellites.

The Associate Administrator for Commercial Space Transportation at the Federal Aviation Administration (FAA), George Nield, gave the plenary keynote speech on how space traffic management (STM) is one of the most pressing space issues facing humanity. While there are regulations that cover space use, such as the 1967 Outer Space Treaty, there is no consensus on internationally binding regulations regarding the management and preservation of the space environment. Along with the increasing number of planned launches and proposed satellite constellations, there are an ever-increasing number of organizations participating in space; governments, private companies, and academia included. Any such international STM architecture must consider the diversity of space activities to the safe access into space for all.

Nield discussed the primary paths with which STM can be conducted: provision by an international organization, a non-government organization (NGO) or through a governmental agency. If STM were to be regulated by an international body, he sees several key issues would limiting its effectiveness. Firstly, there are no current organizations willing or able to take on the responsibilities of such a task. Should such an international organization be created for this purpose, how would it be funded to ensure consistent services and how would it be able to garner international agreements on issues when there are political differences between countries? A point raised later in the plenary by Simonetta Di Pippo, Director for the United Nations Office for Outer Space Affairs, organizations such as the United Nations follows the

Plenary 3: Space Traffic Management – Global Challenges to Protect the Strategic Domain of Space

directions of its member states. While a United Nations body may bring together nations to collaborate towards a solution, such a regulatory body may have limited capability to resolve disputes between member states or with the private sector.

A privately-funded NGO would have similar issues, Nield continued. Furthermore, such a solution may have issues with the security risk of sensitive data of satellite operations and positions. There may also be financial challenges. Would it be compulsory to pay for STM and space awareness services? What if these fees are too expensive, with governments and other organizations no longer providing support? And could an NGO create compulsory, binding and enforceable regulations?

Instead, Nield proposed that a civil governmental agency, such as the FAA, would be ideally placed to have the responsibility of conducting STM. This type of organization would be able to solely focus on STM as its primary responsibility, rather than as an aside to profit generation or be distracted by international politics. Additionally, it would be well placed to work with all stakeholders on the international stage while constantly supported by government funding. While such an organization may be tied to a specific government, Nield said that it would have to cooperate with the entire space sector to ensure transparency in its operation, and that its services and information should be provided free of charge. Together with other open-architecture measurement and tracking techniques built by other government and private organizations, there can be global consensus on the state of the space environment and a global solution can be worked towards.

One of the biggest issues for STM is the amount of orbital debris currently in orbit around Earth. Paul Welsh, Vice President of Business Development at Analytical Graphics Inc., discussed the enormity of this issue for current and proposed satellite missions. Satellite constellations, such as the planned OneWeb communications constellation of approximately 650 satellites, can expect to have some 300,000 warnings of near-debris collision events. This excessive number of potential collision event warnings results in satellite operators not knowing whether they should commit

their limited satellite fuel supply to avoid a potential impact (with potential loss of satellite operations).

To improve the accuracy of debris impact predictions, the Deputy CEO for the Space Environment Research Centre, David Ball, discussed how organizations such as his are working on improved prediction of debris behaviour, however, there is still a long way to go, including understanding the effects of atmospheric drag at high altitudes and solar radiation on debris of different shapes and sizes. Scott Kordella, Portfolio Director for

the National Space Programme at MITRE Corporation, discussed how another method of improving STM would involve machine automation, where satellite avoidance of debris could be done in a similar method that autonomous cars detect and avoid objects.

No matter what the solution, the issue of space traffic management is something that needs to be resolved in a collaborative international effort. Only then can humanity reap the benefits of space while preserving the space environment.

aiming to use only four of the seven seats within the crew capsule, with the remaining seats either to be used as extra space for cargo, or seat astronauts from NASA partners, or space tourists. Flight tests are planned for 2018, with initial service missions of the crew capsule to occur in the following 5 years.

To ensure the safety of the passengers (both astronauts and non-professional space tourists), specific training programmes must be developed for each launch method to space. George Nield, the Associate Administrator for Commercial Space Transportation at the Federal Aviation, discussed how space travel is inherently risky. He sees that training programmes for space tourists, such as the ones discussed by DalBello and Cornell during the plenary would need to be further developed prior to commercialisation. Furthermore, governments

need to develop industry standards for private space launches to ensure not only public safety, but also the safety of the crew capsule occupants.

Whenever the community of space faring nations gets a sample return mission to the red planet, it will have made that important decision on where and what to sample. Session speaker, Professor Jonathan Lunine, Cornell Center for Astrophysics and Planetary Science Director, said the Committee on Space Research (COSPAR) should play a large role. "COSPAR is an entity that over 50 years, maybe 60, has helped coordinate science cooperation between countries and we could expect COSPAR will play a big role in the exploration of Mars and the science coordination, as many countries ramp up Mars exploration programmes."



Plenary 4: 50 Ways to Leave Your Earth

Commercial companies are developing many new methods to get to space, offering the opportunity for both astronauts and non-professionals to experience the feeling of weightlessness and seeing Earth from space. Although there may not yet be 50 ways to leave your Earth, there are certainly many companies working on this. In the fourth plenary session, three of these companies discussed through their respective human-rated space vehicles that are nearing completion in the next few years.

Richard DalBello, Vice President of Business Development and Government Affairs at Virgin Galactic, described through the flight profile of SpaceShipTwo, Virgin Galactic's sub-orbital launch service being developed with the goal of democratising space access. Taking off from the purpose-built Mojave Air and Space Port in California, United States, SpaceShipTwo would be taken on a launcher aircraft, the White Knight Two. When SpaceShipTwo reaches its launch altitude, it detaches from the launcher aircraft to continue flying through the atmosphere to just space. DalBello spoke of how SpaceShipTwo would then glide back to land at the Mojave Air and Space Port, giving four minutes of zero gravity for a total flight time of two hours. Not only is SpaceShipTwo capable of launching space tourists, it would also be equipped to fly research payloads.

The Head of Astronaut Strategy and Sales at Blue Origin, Ariane Cornell, told the plenary of their vision

of missions of people working in space. Key to achieving this vision, Blue Origin is developing "operationally reusable" rockets, capable of both launching and landing. Cornell reported that Blue Origin are planning to launch space tourists in the next two years in the New Glenn rocket. Based on the its predecessor, the New Shepard rocket, the New Glenn rocket would be able to reach sub-orbital space and provide passengers four minutes of zero gravity in space.

Finally, Chris Ferguson, Director of Crew and Mission Systems at The Boeing Company discussed his company's human-rated crew capsule, the CST-100 Starliner, which has been designed for NASA service missions to the International Space Station, launched on the Atlas V rocket. The CST-100 Starliner incorporates a wide range of safety features such as autonomous emergency detection and egress systems, and airbags to enable the capsule to land on all types of surfaces. Together with NASA, Boeing has conducted simulation of mission phases, and developed a new spacesuit to ensure passengers on the CST-100 Starliner are well protected. Ferguson further spoke of how NASA is



Plenary 5: Innovative Methods for Assured and Secure Access to Space Resources – Next Generation Plenary

Different innovative methods of using and removing space debris from Earth orbit was discussed during the Next Generation plenary session.

Christianna Taylor, founder of Intelligent Space and member of the National Society of Black Engineers Space Special Interest Group, discussed how crowded space is. There are approximately 4,000 non-functional satellites in space, or 3 in every 4 satellites. Intelligent Space aims to recycle these dead satellites into useful products, using Artificial Intelligence to identify what components and structures can be made in space. By using the already existing resources in space, Taylor hopes to develop a manufacturing capability in space while securing crowded satellite orbits.

Wei-Yu Louis Feng, studying a Master's Degree in Space Studies at the University of Cape Town, discussed his thesis project known as MEDUSA: Mechanism of Entrapment Debris Using Shape-memory Alloy. Based on the Venus flytrap, MEDUSA is a low-cost, small-scale and reusable active space debris removal device which

uses shape memory alloy to open and close the five-arm device, capable of capturing objects between 10 to 20 cm in size. It is currently undergoing design iterations, with the aim of improving its volume-catching capability in order to be able to be inserted into a 3-unit CubeSat.

Doris Grosse, Research Scientist at the Australian National University Research School of Astronomy and Astrophysics, discussed how there are a lot of small objects in space that do not justify the cost to remove them. Grosse told of her work using a high-power laser to disturb the orbit of these small objects to the point where the object naturally de-orbits into the Earth's atmosphere. Using a secondary laser as an artificial star, they have compensated for the atmospheric disturbances to the primary laser beam by understanding how the light from the artificial star is affected. This effectiveness of this technique is limited by the characteristics of the target object – flat, reflective surfaces of low mass work best – and by the power of the primary laser, which is currently limited to between 8 to 16 kW of power.



Andrew Ratcliffe, Head of Launch Systems at the UK Space Agency, discussed the development of a space harpoon to capture space debris with the collaboration of Airbus and the European Space Agency. This system uses compressed gas to launch the smart projectile at a target satellite. While the system can rendezvous with tumbling objects at a safe distance, it has a potential risk of creating more space debris. Ratcliffe reported that further work is required prior to operation of the space harpoon, such as understanding the dynamics of a two-object-and-tether system, and the need to develop a legal framework regarding ownership of reclaimed satellites; especially as to who has liability should an issue arise with captured space debris.

The last speaker of the Next Generation plenary session was Matjaz Vidmar, a PhD student in Science,

Technology and Innovation Studies at the University of Edinburgh and Royal Observatory Edinburgh, discussing trends in space activities. New space companies typically have a flatter structure, with less of a focus on hierarchy of people. Academic research is becoming more open, allowing for back and forth collaboration between businesses and academia to provide a link to commercialise innovative new ideas. Additionally, there is more of a focus on securing intellectual property issues prior to commercialisation of an idea. Vidmar believes that the greatest challenge for those starting a new company or research is a potential loss of autonomy in order to secure funding. This loss of autonomy can unintentionally alter or limit innovation potential, due to the need to conduct other work separate to research and development.

Plenary 6: Moon-Mars Villages for Science, Technology, Innovation, Cooperation, Security and Inspiration



The varied human-robotic missions planned to explore and facilitate the exploration of the Moon and Mars in the near future was discussed in the sixth plenary session.

Extensive research activities have been conducted for both the exploration of the Moon and Mars. Bernard Foing, Astrophysicist and MoonMars Scientist at the European Space Agency (ESA) and Executive Director of the International Lunar Exploration Working Group, discussed how by studying the Moon and Mars we can understand the formation of rocky planets. Jan Woerner, the Director General of ESA, discussed

the concept of having a Moon Village, an open architecture collaboration of organizations who wish to work either independently or collaboratively for the benefit of all. While Woerner expressed that the Moon Village can just involve robots working together, Sergey Krikalev, Executive Director for Manned Space Flight Programmes at ROSCOSMOS, reported that sooner or later astronauts will join the Moon Village to compliment robotic exploration of its surface. Krikalev echoed the importance of having an open architecture for the Moon Village, where the lack of a fixed programme can be harnessed as inspiration to participants to conduct research.

Francois Rivasseau, Director of Security Policy and Space Policy at the European External Action Service, discussed the security needs of the Moon Village; having security of energy, resources, and security against the space environment. Rivasseau also talked about the importance of not using space to provide security for Earth.

Robotic exploration was discussed by several plenary panellists. Pascale Ehrenfreund, Chair of the Executive Board of the German Aerospace Centre, reported on various autonomous vehicle projects the Centre is designing in collaboration with the Helmholtz Alliance the "Robotic Exploration of Extreme Environments" (ROBEX), an alliance of 16 institutions across Germany. David Korsmeyer, Director of Engineering at NASA Ames, spoke of their plans to use the Moon as a test bed for the development of technology, such as NASA's plans to launch 12 nanosatellites into lunar orbit for the development and validation of technology. Using autonomous vehicles for the exploration of the Moon and Mars is currently the most cost-effective method to conduct research of the two bodies, however, as Krikalev

raised, the high latency between commands and execution means that joint human-robotic exploration would be the most efficient.

The use of simulated Moon and Mars environments on Earth plays a key role during the development of space missions. Tai Sik Lee, President of the Korean Institute of Civil Engineering and Building Technology (KICT), spoke of the KICT Extreme Environment Test Centre, which will be completed in 2018. Autonomous vehicles within the 4,000 Litre capacity vacuum chamber will be able to undergo their mission, tested by the various different environments which can be created within the chamber. The use of simulation environments for human exploration and research to generate inspiration was discussed by Joao Lousada, an Analogue Astronaut for the 2017 PMAS Simulation at LunAres Base and Monika Johanna Pardo Spiesse, Winner of the SGAC/ILEWG IAC 2017 Article Prize Competition. Not only can we develop higher quality space missions, by conducting simulated missions on Earth, we are able to use these programmes to inspire and engage people on the benefit of missions to explore the Moon and Mars.



Plenary 7: Next Generation On-Orbit Satellite Servicing and Refuelling Programmes

The ability to conduct on-orbit servicing and refuelling of existing satellites could potentially transform how satellites are managed and operated, heard the seventh plenary session. The plenary also heard from several different companies aiming to provide this service to satellites.

The primary goal of on-orbit servicing and refuelling of satellites is to extend the value of existing infrastructure told Tony Colucci, Vice President of Business Development at Space Systems Loral. Currently, when a satellite reaches the end of its life,

has experienced malfunctions which significantly affect its performance or has run out of fuel, it is either de-orbited into Earth's atmosphere or placed in a graveyard orbit. Colucci compared this behaviour to what is done for ground-based assets, explaining how wasteful this practice is. If our car runs out of fuel or has a tyre puncture, we don't buy a new car. We instead refuel or repair the car as required. This discussion was continued by Paul Sheridan, Vice President of Optus Satellites, whose company currently operates five Geostationary Earth Orbit (GEO) satellites. Sheridan spoke of how running low on fuel is the main



reason for satellite decommissioning, and this, as per international regulations, requires the satellite to be removed from orbit and disposed of.

Three of the plenary panellists spoke of their company plans to conduct life extension missions. Shahida Barick, Head of Satellite Operations at Effective Space Solutions (ESS), and Tom Wilson, President of Space Logistics LLC, both spoke of ambitions to service GEO satellites, which alone is a market worth more than \$10 billion USD. Barick reported on how their satellite, known as a “space tug”, would dock with a target GEO satellite using the launch interface ring, the structural interface between the satellite and launch vehicle. Once attached, the ESS space tug would provide life extension using ion thrusters. Wilson spoke of their plans to be able to provide up to 6 years life extension to a GEO satellite, with a test space tug being launched in 2018. This was similarly echoed by Michel Frezet, Head of On-Orbit Servicing at Airbus Defence and Space, who reported on his company’s plans to use their space tug to provide payload exchange for satellites and space debris removal from as early as 2022.

Robert Feierbach, Vice President of Business Development at Space Infrastructure Services, discussed his company’s plans of a full-featured, on-demand robotic service spacecraft. Utilising its two 6-foot long robotic arms, this spacecraft would be able to conduct satellite inspection, repair, refuelling, relocation, and upgrade services, with the aim to start services in 2021. The CEO of JKIC, Joerg Kreisel, spoke of their plans to use modular satellite hardware to enable the easy alteration and modification of satellites. Kreisel discussed how their system used a common interface, similar to the USB port in usage, capable of providing thermal, data, mechanical and electrical interfaces between two modular components.

Peter Swan, President of the International Space Elevator Consortium, spoke of the use of space elevators to access Earth orbit. While this capability would not be available anytime in the near future, Swan hopes that this transportation method could provide frequent and safe transport of goods to space at a price less than \$100/kg.

One key point raised by Sheridan during the discussions of on-orbit satellite servicing and refuelling technologies was that this capability would not mean the end for satellite manufacturing. We are constantly developing new technology, which will always be in high demand as these technologies can provide increased performance. Developing this new capability to refuel and repair operating satellites merely opens another option for satellite operators such as his company. One thing is for certain though; the capability of on-orbit satellite servicing will open up opportunities for both technology developers and satellite operators.

participants increase and as technology develops. Stuart Minchin, Chief of the Environmental Geoscience Division at Geoscience Australia, reported on Digital Earth Australia, which packages almost 30 years of Earth observation data of the entire surface of Australia into 25 m² pixels. Using this product, Minchin explained how users would be able to conduct data mining on extremely specific areas of Australia, such as finding locations of water or detecting coastal change over past decades. The CEO and Co-Founder of Sinergise, Grega Milcinski, discussed two of his company’s products: Sentinel Hub Playground and Global Forest Watch. Sentinel Hub Playground uses satellite imagery from the Sentinel-2 satellite mission to provide users the capability to view Earth in many different spectral images, while Global Forest Watch is an interactive forest monitoring and alert system designed to assist users to better manage and conserve forests.

But there are issues of such large sets of data produced on a continuous basis. Aditya Agrawal, Director of Data Ecosystems Development at the Global Partnership for Sustainable Development, spoke of how the required data is often not easily accessible, or of high enough quality to be of use. It may also be disaggregated, or not easily provide the required dynamic picture of what is being measured. Milcinski reported on how data users may experience information overload due to the vast quantity of data that organizations such as his need to examine. He discussed how his company has used automated filtering techniques such as machine learning and statistical processing to produce only the useable data, thereby providing cost and time savings without decrement to the data quality.

The issue of privacy of Earth observation data was also discussed by the panellists. Agrawal spoke of how

metadata could be used to restrict access to potentially sensitive data to users. However, this is not seen as too much of an issue by Minchin, who discussed how the resolution of Earth observation satellites is not as good as what people would expect; limited to not much better than 25 m² pixels. He explained how it would only show “what you could see over your neighbour’s fence”, only affecting the accessibility of what could already be seen rather than providing any real privacy intrusions.

So what should be done to continue the sustainable growth of Earth observation data to ensure lasting benefits? Brendan Bouffler, Manager of Amazon Web Services Research Cloud Programme discussed how exceptionally hard it is to move data around, despite significant improvements to computer processing power and storage. Bouffler spoke how Amazon has been able to solve this by shifting the data processing and storage to a cloud service, reducing both the cost and time to access and use the data. Both Agrawal and Minchin spoke of how governments need to collaborate with each other and with private industry to provide a broader and more open access to data and to accommodate the use of public infrastructure by industry. This would provide significant benefits to humanity by lowering the cost of knowledge.



Plenary 8: From Up There to Down Here – Big Space Data Driving Sustainable Development and Economic Growth on Earth

In recent years, there has been a massive boom in the creation of big space data sets from Earth observation satellites. In Plenary 8, the panellists discussed how data has been used to open up opportunities for their respective companies and the potential challenges facing the use of this data.

There has been over a hundredfold increase in the volume of data generated from the previous generation to the current generation of satellites told Harry Cikanek, Acting Director of the Centre for Satellite Applications and Atmospheric Administration. This trend is expected to continue as the number of



IAC 2017 Highlight Lectures

Highlight Lecture 1: Flight by Light with Bill Nye – LightSail® and Innovations in Solar Sailing

Using light produced by the sun as a method of spacecraft propulsion to explore the solar system may seem like science fiction, but as Bill Nye, the CEO of The Planetary Society told the packed Highlight lecture, this is something his company is aiming to achieve.

The use of solar sails as spacecraft propulsion has been experimented with for over 20 years. The Japan Aerospace Exploration Agency (JAXA) had launched a Venus orbiter in 2010, the IKAROS, which demonstrated the use of a solar sail for both accelerating and manoeuvring a spacecraft. Solar sails provide propulsion to spacecraft by reflecting incident solar photons, providing a near constant $9 \mu\text{N}/\text{m}^2$. By altering the angle of the solar sail, the spacecraft can move towards or away from the sun, using similar methods to sailing boats moving on. While the sail material is very expensive, its low mass and lack of need for conventional propulsion systems opens up exploration of the entire solar system.

The Planetary Society has built two orbital 3-unit CubeSats equipped with solar sails, the first having been launched in May 2015 and the second planned for 2018. The first satellite, LightSail-One, suffered some software and camera issues, but the mission was an overall success with deployment of its solar sail. Using the lessons learned, The Planetary Society will build LightSail-Two, planned to launch alongside the Prox-1 mission, which will have a greater solar sail area than the previous design, and will also have the added feature of being able to manoeuvre, in addition to being able to accelerate. Nye spoke of the various risks that they are needing to mitigate or solve for LightSail-Two, such as the deployment of the solar sail. There is no vacuum chamber large enough to accommodate the deployed solar sail, and as such, this process cannot be tested prior to launch. Nevertheless, Nye is very confident of the success of LightSail-Two.

Nye spoke also of the political advocacy and public outreach that The Planetary Society conducts. With over 50,000 members in more than 100 countries, the society can lobby governments across the world to conduct space exploration missions. Two such missions were the New Horizons mission that conducted a flyby mission of Pluto in 2015, and the Europa Clipper, which is planned to fly to the icy moon of Jupiter after its launch in 2025. In addition to lobbying for space exploration missions, The Planetary Society participates in spreading the global benefits of science, advocating for its economic and social benefits. It is truly an extraordinary time that we are living in, where global citizens – not part of a government or private company – are able to actively contribute to the advancement of human knowledge.



Highlight Lecture 2: The Great Barrier Reef: Assessing its Health from Space

The Great Barrier Reef (GBR) is one of the great natural wonders of the world. It has been inscribed on the World Heritage List since 1981, and is estimated to be at least 500,000 years old. However, this natural wonder is under attack. In this Highlight Lecture, Paul Hardisty, CEO of the Australian Institute of Marine Science, spoke of the beneficial impact the GBR has for the local communities and marine life, as well as sources of damage to the reef, monitoring methods, and how the reef can be preserved.

The GBR, located on the north-east coastline of Australia, is home to a vast number of marine species such as whales, dugongs and other fish species, and with an area of 344,400 km², it is one of the few living structures that are visible from space. Not only does it have vast benefit to marine life, it has become part of the Australian national psyche. It has a long and profound connection to the indigenous peoples of Australia, and supports over 60,000 jobs in local communities across the GBR coastline. Coral is formed by the symbiotic relationship between a hard calcium carbonate structure and a living plant-like algae creature, together forming a coral polyp.

What are the sources of damage to the GBR? Hardisty reported how coral bleaching events have become more common and widespread across the GBR and the world, occurring from the ocean acidification and rising water temperatures due to Climate Change. Coral bleaching events kill the coral, where it loses its colour to a skeleton white and becomes brittle. The death of coral in a localised area devastates the local marine life, forcing them to try and locate a new home. Occasionally, coral can rejuvenate back to some extent provided the conditions remain favourable. Hardisty spoke of how satellite imagery has been used to map areas of dead



coral, however, this method still lacks the resolution that is needed. Areas of dead coral often look similar to that of alive coral due to the algal blooms that may cover coral after its death. Hardisty spoke of how hyperspectral imagery could be used to differentiate between alive coral and algal bloom.

Another threat to the GBR is the impact that weather events such as cyclones can have on the reef. First of all, the cyclone can directly damage and destroy coral reefs through wave force and impact with the coral. It also causes the water to become turbid, limiting access to the light the coral requires for growth. Lastly, the water surface runoff from the coast due to strong rains carries chemicals used in agriculture into the reef. This negatively affects the biological environment of the coral reef, and promotes outbreaks of crown-of-thorn starfish that prey on coral.

Coral reefs are being forced to live in a warmer world, one that they cannot escape from. Being static structures, they lack the ability to move, and are not able to adapt due to their slow growing nature, and so are forced to die. We are running out of time to save our precious coral reefs, and as we progress further into Climate Change, the pressure on them will not ease. Hardisty discussed how we could protect coral reefs by enhancing the rate at which the reef recovers, by restoring lost corals using laboratory-grown coral, by reducing their exposure to threats, or by conducting genetic engineering to improve the tolerance of coral to its environment. One thing is for certain. We need to ensure the preservation of all coral reefs across the world due to the vast impact they have. The cost of preservation is far less than the cost of restoring these reefs, so the time for action is now.

IAC 2017 Late Breaking News

IAC World Space Award Highlight Lecture: International Cooperation in Space

The IAF World Space Award is presented only to those people who have made an outstanding contribution to space science, space technology, space medicine, space law or space management to the level of having an exceptional impact to humanity's progress in astronautics. The third recipient of this award was Charles Bolden, President and CEO of The Bolden Consulting Group LLC and Administrator of NASA from 2009 to 2017, who was given the opportunity at IAC to discuss his experiences.

Bolden talked about how the international space sector has repeatedly shown its ability to work together towards common goals, aspirations and values, regardless of politics and tensions between countries. We understand the importance of working together, especially to achieve the big dreams we all have. As such, the International Space Station, a platform to conduct scientific research and technology development in micro-gravity, should be given a Nobel Peace Prize due to its effect across

the world on international collaboration ever since the launch of the first components in 1998. There are now even more partnerships between the private and public sectors, not only in designing and constructing space vehicles and satellites, but in conducting collaborative research missions across the solar system.

Bolden also discussed the benefits of the space industry to humanity, particularly its ability to inspire people. The Apollo 11 mission to land on the Moon had a huge inspirational impact not only in the United States, but across the globe; even to those nations who at the time were on opposing sides in the Cold War. Imagine what the impact of landing on Mars could have for humanity? Bolden described how he believes that in the future, life on Earth will be improved thanks to the innovation and inspiration provided by current and future space activities. Space will be a place where the only competition is the competition of ideas.

Late Breaking News I: We are Explorers - Plans about the Mars Base Camp and the Deep Space Gateway



Never before have we had the technology and public interest to conduct deep space human exploration to the Moon and Mars. Robert Chambers, Programme Strategy Lead for Orion Production, Tim Cichan, Space Exploration Architect, and Danielle Richey, Advanced Programmes Exploration Architect, detailed Lockheed Martin's plans for the Mars Base Camp and the Deep Space Gateway; two space stations to facilitate the exploration of Mars and the Moon respectively.

Why do we explore space? Chambers discussed how there have been fundamental existential questions that humans have been asking for thousands of years. Where do we come from? Where are we going? Are we alone in the cosmos? By exploring Mars, we will conduct science to directly assist providing answers to these questions.

To achieve real-time control, we need to have humans on or in-orbit of Mars. By using both humans and robots together, we will be able to achieve so much more than what can be done separately. Additionally, having humans on Mars provides the capability to react and deploy probes or rovers to locations of immediate interest.

Chambers, Cichan and Richey all discussed Lockheed Martin's vision for the Mars Base Camp space station, a platform to conduct real-time scientific research and exploration of Mars. Built around the Orion crew module, this platform would be able to facilitate in-situ sample analysis of Mars. Richey described how these samples could be analysed on the space station by the six crew members using the 6,800 kg and 40 kW of power allocated to scientific equipment. Chambers spoke of the safety systems that would be included on the Mars Base Camp, such as multiple redundancy of all critical systems. This is important since there will not be the same level of support that can be provided to Earth- and Moon-orbiting space stations, should something go wrong.

Lockheed Martin's single-stage, reusable aero-spacecraft lander was unveiled by all the speakers. Richey detailed how the lander would be able to support four astronauts for two weeks on the surface of Mars, enabling them to achieve their scientific objectives before launching back up to the Mars Base Camp. Cichan detailed the specifics of the Mars lander, describing how the cabin section would be based on the Orion crew module currently in development by Lockheed Martin. Furthermore, the lander would have a delta-v capability of 6 km/s with its liquid oxygen and hydrogen propulsion system, allowing it to leave the Mars Base Camp and return back again, without the need to generate additional fuel while on the surface of Mars.



Mars is a dynamic and active planet, despite its first-glance appearance as a dead, desert planet. To explore Mars properly, we must act in a similarly dynamic manner. We are not currently able to do this with the use of only robotic vehicles on Mars, which has up to 25 minutes communication delay from Mars to Earth.



So how does this relate to the Deep Space Gateway, the NASA-proposed cis-lunar space station to orbit the Moon? Cichan described how the Deep Space Gateway can be used not only to conduct important scientific

research of the moon, but also to provide a test bed for deep space human exploration technologies and procedures. We would be able to build on the lessons learnt from the Deep Space Gateway to maximize the impact of the Mars Base Camp.

Cichan discussed how we do not need to invent new technologies to make the Mars Base Camp and Deep Space Gateway a reality. We have already built and developed all the required technology needed to construct both space stations. By using international collaboration with both public and private organizations, we could make both space stations a reality as early as the late 2020's.



Late Breaking News 2: Sky and Space Global Conducts First Ever Voice Call using its Nano-Satellites

Does the offer of affordable telecommunications available anywhere at any time sound too good to be true? Not to Meir Moalem, CEO and Managing Director of Sky and Space Global (SSG), who discussed his company's achievement on conducting the first ever phone call using nano-satellites.

Much of the world does not currently have easy access to telecommunications, particularly remote, developing nations who do not have the resources to construct expensive ground telecommunication networks. To solve this issue, Moalem described how SSG plans to use a constellation of 200 nano-satellites in equatorial Low Earth orbit to provide telecommunication services to the world. These nano-satellites would communicate to each other using a narrowband connection, allowing customers to communicate to people on the other side of the world.

Moalem discussed how his company has entered a partnership with Check Point Software Technologies to provide a dual layer protection of cyber security to

their telecommunications system. All SSG satellites will encrypt all non-military communications through their satellites, providing security customers. For the second layer of cyber security, Check Point Software Technologies will also provide SSG with a software protection system.

In September this year, SSG successfully demonstrated phone calls, messaging, voice-recordings and image transfers between different users through their three demonstration nano-satellites, launched earlier in the year. Additionally, Moalem reported on how his company has been able to successfully demonstrate the ability of their technology to receive a message, store it in satellite memory, and then downloading it to the receiver at a later time. This capability is a key step on the road for SSG to achieve its goal of "providing affordable communication services to anyone, anywhere, anytime".



IAF Global Networking Forum (GNF)



GNF Sessions: Day 1

The first day of GNF sessions featured four different presentations, discussing the paradigm shift known as 'New Space'.

Meir Moalem, CEO and Managing Director of Sky and Space Global (SSG), reported on how his company has used New Space principles to achieve their goal of affordable communications for anyone around the world at any time. New Space is an evolution of making technology smaller, faster and cheaper. Instead of the traditional lengthy design, manufacturing, validation and re-validation processes, SAS Global (SSG) uses rapid, iterating design and testing cycles with already developed technology. This reduces the risk and expenditure of resources, and has enabled them to launch three small satellites within 18 months of the founding of the company.

John Elbon, Vice President & General Manager of the Boeing Company, reported on the long partnership between RSC Energia and Boeing involving human spaceflight, including the Apollo-Soyuz test, the Mir Space Station and the International Space Station (ISS). Vladimir Solntsev, General Director of RSC Energia, then told of his hopes for continuing this collaboration of not only companies, but also countries, into the future. Elbon and Solntsev both discussed their respective company plans for shaping the planned NASA Deep Space Gateway, as well as their own planned collaborations on lunar and Mars exploration missions.

The final two sessions saw Pierre Delsaux, Deputy Director General for Internal Market, Industry, Entrepreneurship and SMEs, and François Rivasseau, Special Envoy for Space for the European External Action

Service, speak about future ambitions and direction for Europe in space. Space programmes developed in collaboration by groups of EU Member countries would have a greater impact than if done individually, with each such group being able to focus on a specific area of speciality.

Delsaux described each of the three primary systems operated by the EU; EGNOS for enhancing GPS signals, the European GPS satellite service Galileo, and Copernicus, which provides an open-access database on a wide range of Earth observation activities. He also spoke of the importance of a coordinated and unified space strategy to be able to understand what challenges need to be solved. Rivasseau concurred with the importance of long-term visions for space, but stressed that wishes of each of the EU Member states need to be balanced before large-scale exploration activities can be conducted.





GNF Sessions: Day 2

The second day of IAC had five Deep Dive GNF sessions. Each of these sessions explored in detail several of the key aspects of the use and preservation of space for Earth satellite operations.

Fritz Merkle, Member of the Management Board for OHB, discussed the many different types of Earth Observation satellites currently in use. The more commonly known types are those that use the visible or infra-red spectrum of light to observe Earth's surface. These operate by observing the respective electromagnetic spectrum frequency ranges being radiated or illuminated by the Sun of the viewing area, provided there is little or no cloud cover to obscure the target. Merkle also discussed the use of hyperspectral satellites, which can be used to conduct spectral analysis on each colour pigment due to the far superior colour differentiation to the visible spectrum-sensing satellites. Lastly, the use of radar for Earth Observation was discussed. This method illuminates the surface of Earth, providing the capability to observe an area regardless of time of day or weather.

The President of Blue Origin, Rob Meyerson, shared his company's developments on the construction of the New Shepard sub-orbital launch system, which resulted in the company becoming the first to successfully land a rocket booster after being launched into space. Blue Origin is working towards having operational reusability for their launch vehicles, which has been demonstrated by the repeated launch of New Shepard rockets without requiring post-flight maintenance or analysis. Meyerson continued, discussing the company's development of the New Glenn orbital launch vehicle, which is also capable of operational reusability. By designing minimal maintenance into their vehicles, similar to the commercial aircraft industry, Blue Origin is aiming to be able to launch a rocket every week.

Travis Langster, Vice President of Analytical Graphics Inc., discussed space situational awareness for satellites, with the need for both current and predictive elements of the space environment. Currently, there are over 23,000 objects in space of 10 cm or greater in size being tracked, however it is estimated that this forms less than 4% of the total number of orbiting objects in space.

The unwanted objects, known as space debris, can be exceptionally difficult to track if in a high-altitude orbit or of a small size. Space debris of 2 cm in size can cause catastrophic damage to satellites, and potentially result in the creation of even more space debris. Langster reported that just in the past three months before IAC there had been three satellites that had experienced loss of control, likely due to such a collision with space debris. To manage this risk in this age of increasing satellite launches, accurate and predictive space situational awareness is needed.

The impact and use of satellite constellations was discussed by Bruce Chesley, Senior Director of Strategy, Space and Missile Systems at The Boeing Company. He spoke of the capability of constellations to provide for the ever-growing demand for bandwidth, services, and consumption patterns. By linking together many satellites into a constellation, the entire system can allow for customer mobility, flexibility of ground station infrastructure, improved capability of scaling the constellation, ubiquitous coverage, and provide services at a lower latency than the more traditional satellite services.

The last speaker at the GNF Deep Dive sessions was Peter Marquez, who spoke of the link between governments and industry in conducting space activities. He discussed the three primary "ingredients" for conducting space activities: an understanding of the purpose and goal of what you are trying to achieve, having the knowledge and capability to realise that purpose and goal, and having the funding or business potential. Marquez continued, discussing what governments and industry should do to ensure the success of their space activities. Governments need to have clear goals and programmes available for all to understand, and ensure these are kept stable between successive governments. If a government wants to have a specific capability, they need to be able to coordinate and assist industry to ensure that capability is met, such as through policy changes or funding. Companies within the space industry need to understand how they fit into the global stage, and how they can work with other companies or governments.

GNF Sessions: Day 3

Project management methods to develop successful space and defence programmes, and the future of deep space exploration, were just some of the GNF session topics held on the third day of IAC.

Space programmes are known for their use of advanced technology for inspirational achievements. To ensure the success of space activities, organizations must balance and manage the cost and risks of operating in the space sector. The use of a disciplined project management and oversight process is becoming more common, with the use of design reviews, cost analysis and risk mitigation strategies. Tools, such as Technology Readiness Levels (TRL), have been used to gauge the potential risk of incorporating technology into a space programme. Technologies with a low TRL value have a lower maturity of development, and as such, potentially higher levels of risk which require mitigation. Reviews should occur throughout the project, not just as a point activity, and should involve a multi-disciplinary team. Data should be collected in a structured and thoughtful method during the entire project, which when collated into a database, can be formatted into lessons learnt from previous projects and to provide an understanding as to what works and does not work.



Care must be taken to ensure that we do not become too risk adverse. Risk is often unavoidable in the space sector, especially with innovative new technology or with planetary exploration. If space activities were to have minimal risk, they would provide little to no benefit to society or scientific advancement.

Asteroid return missions, developing a new space station, and lunar surface exploration were some of the deep space exploration missions discussed. Hayabusa 2, developed in partnership between the German Aerospace Centre, Japan Aerospace Exploration Agency and the Centre National d'Etudes Spatiales, will be rendezvousing with an asteroid in mid-2018 to conduct a return soil sample. The public and private organizations' co-development of the Deep Space Gateway in Moon orbit will provide a platform to zero-gravity research, and will support renewed human and robotic exploration of the Moon in the 2020's. Techniques learnt from these expeditions to the Moon can then be used to develop Mars expeditions. By conducting these exploration missions, we are able to provide wide ranging and immeasurable benefits to humanity; providing social and economic benefits, fostering international relationships, advancing scientific discovery, and improving education of all through engaging and inspiring the human mind.



GNF Sessions: Day 4

The fourth day of GNF sessions heard about global partnerships involving space access, and of the recent trends and paradigm shifts experienced in Earth observation.

Global partnerships have driven humanity's presence in space, and is set to continue into the future as space activities shift from being government-sponsored missions to commercial frameworks. Robert Lightfoot, Acting-Administrator of NASA, spoke on how space activities can be loosely divided into three different categories: develop, explore, and discover. While the development of space can easily be conducted by industry due to its mature economy and direct economic benefits to Earth, exploring and discovering space is still

very much the realm of government space agencies who have the support and financial backing of a nation. To achieve grand concepts such as planetary exploration, we will need to have global partnerships to align our goals and to complement each other's strengths, spoke Mino Rathnasabapathy, Executive Director of the Space Generation Advisory Council. This was continued by Jan Woerner, Director General of the European Space Agency (ESA), and Eric Stallmer, President of the Commercial Spaceflight Federation, who both discussed the importance of including our current young professionals and students, the next generation of space participants. There is a need for actionable steps to achieve global partnerships, not just discussions.

The number of smaller-scale satellite systems and companies conducting space-related activities have been increasing dramatically. Josef Aschbacher, Director of Earth Observation at ESA, reported on how there has been an exponential growth of European service companies, often with less than 10 employees. Aschbacher also spoke on how over 6200 small satellites are expected to be operating in the next 10 years; a significant increase on the approximately 1,500 satellites currently in operation. The Co-Founder and Chief Strategy Officer at Planet, Robbie Schingler, discussed how dividing Earth observation activities across many satellites spreads hardware and capability, thereby reducing the cost of hardware while increasing redundancy. Schingler also spoke of how the developing small launch vehicle industry will be transforming the use of near-Earth space by allowing small satellites to become the primary payload in the launch; setting the launch time and orbit to what suits them rather than having to be a secondary payload in a multi-tonne satellite launch.

Brendan Bouffler, Manager of Amazon Web Services Research Cloud Programme, discussed the use of publicly available Earth observation data sets to conduct business. Using public data allows companies to spend their resources on more beneficial activities. It can be a costly process conducting detailed analysis on data, and by using public databases, less resources are required to achieve the same level of benefit to a company and their customers.



GNF Sessions: Day 5

fragility of Earth, especially in contrast to the darkness of space. The issue of space debris was discussed, where astronauts spoke of the significant hazard this poses to spacecraft. While space debris located in Low Earth Orbit (LEO) has the potential to improve over time by burning up in Earth's atmosphere, there has been minimal discussion as to how to clean up the graveyard orbit. Space environment management should be the responsibility of all participants in space.

Jia Mu, Deputy General Manager of the China Great Wall Corporation, reported on how his company is developing a narrow-band data exchange satellite constellation to provide global continuous real-time communications. Using 60 small satellites in LEO, Mu discussed how the constellation would be able to be used for global asset state supervision and control, personnel and goods positioning, real-time communications service, and to assist emergency rescue after natural disasters. The satellite constellation would be available for use by both government and industry enterprises across the world. Mu spoke of how the first 12 satellites are planned to be launched in 2019, and completed by 2021 to serve the needs of humanity.

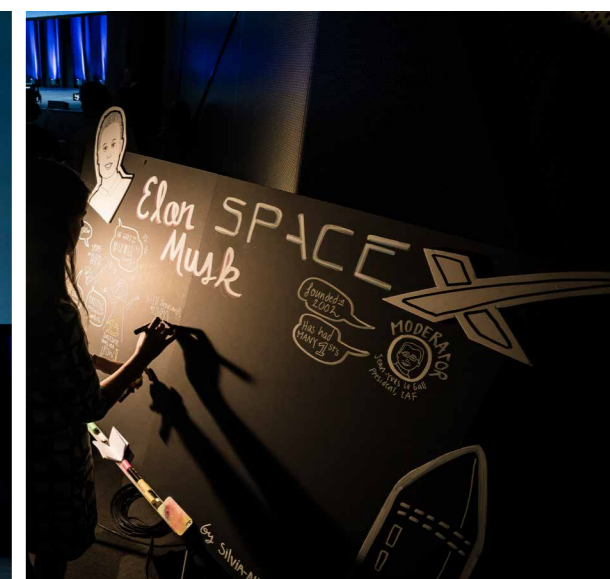
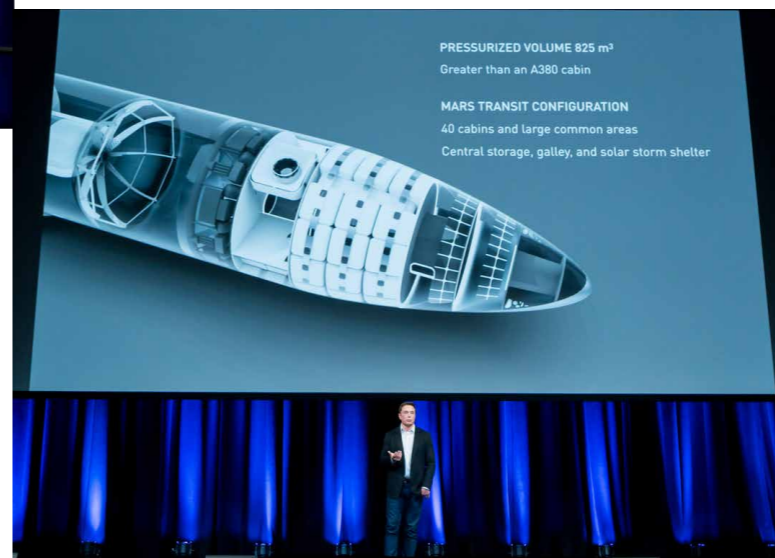
The fifth and last day of the GNF sessions, attendees heard of the experiences of astronauts across the world, the development of a narrow-band data exchange satellite constellation by the China Great Wall Corporation and the highly anticipated update of SpaceX's plan to colonise Mars.

The astronaut event had a panel of nine astronauts from across the world, who provided the audience insights to the life of an astronaut and highlights of their career. Driven by audience questions, topics discussed included experiments conducted on space stations such as the ISS and MIR, health hazards to humans during spaceflight and the growing private and public partnerships. The panel of astronauts also highlighted the beauty and



Elon Musk, CEO and Founder of SpaceX, provided an update on last year's presentation at IAC in Guadalajara, Mexico, on how SpaceX plans to make humanity a multiplanetary species with the colonization of Mars.

Musk detailed the design and layout of the BFR, a fully-reusable two-stage rocket using methane and liquid oxygen as its propellant. The BFR, standing at 106 metres in height and 9 metres in diameter, would have the capability to lift 150 tons of payload into LEO. Both stages of the rocket would be able to return back down to Earth to land and refuel, or as Musk discussed, could be used to land on Mars with enough fuel for the return trip. He hopes to land two BFR rockets on Mars in 2022, providing supplies and equipment to the surface of the planet. These would be followed by 4 BFR launches in 2024, which would carry the first people to settle on Mars. In addition, Musk detailed how he plans to use the second stage on the BFR to provide international flights across the world, flying from any two locations in the world in under one hour.



Educators Professional Development Workshop

The Space Education Outreach Committee (SEOC) and the International Space Education Board (ISEB) collaborated to sponsor the Educators Professional Development (EPD) Workshop, which was held during the 68th International Astronautical Congress (IAC) on September 24 and 25, 2017. The workshop was held at the State Library of South Australia, Hertzell Lecture Theatre in Adelaide, Australia. Approximately 25 local educators participated. The keynote speaker for Day One was Christine Redman, Melbourne Graduate School of Education, Capstone (Chair), Head of Science Education Programme Delivery, University of Melbourne. Two sessions on “Classroom Instruction That Works” were conducted by Michael Pakakis, Ian Christie, and Luca Bertolacci from the Victorian Space Science and Education Center (VSSEC).

Activities focused on an introduction to teaching strategies for which there is scientific evidence of their effectiveness. Participants learned to design effective science instruction, applying classroom instruction that works. The third session was on “Computational Thinking: Applying Learning to Investigation.” The facilitators were Mark Gleeson, Luca Bertolacci, and Danielle Shean. Participants discovered an engaging introduction to the worlds of computer programming and robotics, using Sphero robots. They learned how their students can demonstrate learning, using the “Scratch” language, which is a programming language that makes it easy to create interactive stories, games, and animations and then share the creations with others on the web. On Day Two, the key note speaker was Dr. Koichi Wakata, JAXA Astronaut. Following the speaker, the fourth session was conducted on the Parkes Radio Telescope by Robert Hollow, CSIRO. He explained the interpretation of pulsar data and the techniques for collecting it, then engaged the educators in actually collecting and analyzing data from pulsars of their choosing. The final session was on “Computational Thinking-Connecting STEM to Computer Coding, The States of Matter.” The facilitators were Mark Gleeson, Luca Bertolacci, and Danielle Shean. The workshop was very informative and engaging. Participants made discoveries about the nature of matter and demonstrated their understanding by creating animations. Ian Christie ended the workshop with a summary that responded to the question, “Did We Reach Our Goal?” The answer was a resounding “yes.”



IAF IDEA “3G” Diversity Events

– First Woman on the Moon (Networking Breakfast)



An initiative of the President of the International Astronautical Federation (IAF), Jean-Yves Le Gall, the IDEA event fosters the principle of diversity in geography, generation and gender within the international space community. This IDEA breakfast on Wednesday 27 September heard of the future significance of landing the first woman on the moon, and the plans of space agencies and industry in an inclusive “Moon Village”.



Steve Durst, Founding Director of the International Lunar Observatory Association, spoke of the potential significance of landing the first woman on the moon. Currently, only 60 women have been to space, out of a total of 553 people. Landing a woman on the moon should have the same significant importance as landing the first man on the moon, providing an inspiration to the next generation of women to embark on science and engineering careers. This event may occur from the establishment of a lunar base, Durst continued, establishing humanity as a multi-world civilisation.

The concept of a Moon Village was discussed by Jan

Woerner, Director General of the European Space Agency. Woerner believes going to the Moon is a logical step for human settlement rather than Mars; it is much closer and easier to get to the Moon than to Mars, and travelling there has less of a safety risk. The idea of the Moon Village is to have a community of countries cooperating in exploring an area of the Moon, bringing together a diverse range of interests, participants and activities. This Moon Village would be an open concept, which as Woerner explained, means that there is no single goal or project, no fixed end-to-end plan, or defined scheme for cooperation. The Moon Village would instead have an open architecture, with free and open access to all who wish to participate.



Danielle Richey, Systems Engineer at Lockheed Martin SSC, discussed how industry could contribute to the Moon Village concept. Using the proverb, “If you want to go fast, go alone. If you want to go far, go together”, Richey discussed how we need to cooperate to make the Moon Village a successful reality. She also discussed the NASA-led NextSTEP partnership programme which has

public-private cooperation for the development of a cis-lunar space station, known as the Deep Space Gateway. Such partnerships will provide the synergy for much improved end results.

The last speaker of the IDEA Breakfast was Sandy Magnus, Executive Director of The American Institute of Aeronautics and Astronautics, who provided an astronaut's perspective on collaboration and diversity. She discussed how we often talk about achieving the first of things – such as getting into space, conducting a space-walk, landing on a body – and how this does not

necessarily indicate what work has been done prior to that achievement. Magnus also discussed how we all need to build diversity in our communities, and that we cannot wait for this to naturally occur over time. The benefits of diversity are too great. We all need to be open to change, and to listen to others. Magnus explained that this will require energy and patience, and that we should step out of our comfort zones to not only build our own networks, but to also seek others with different experiences and opinions and to learn from them. We all have something to contribute, we just need to be inclusive.



This “IAF Excellence in “3G” Diversity Award” is intended to recognize IAF member organizations (industry, government, academia) worldwide for outstanding contributions to the fostering of “3G” (Geography, Generation, Gender) Diversity within the space sector. It is an annual award presented at the IAC, but is given only when nominations of exceptional merit are received.

For its exceptional engagement towards diversity, the IAF was proud to present the very first IAF Excellence in 3G Diversity Award to:



Mohammed Bin Rashid Space Centre – MBRSC

The award was presented during the 68th International Astronautical Congress (IAC) in Adelaide, Australia during the IDEA luncheon.

Mohammed bin Rashid Space Centre (MBRSC) was created and established by the Dubai Government in 2015. The Centre is integral to the strategic initiative put in place by the government to inspire scientific innovation, technological advancement, and to advance sustainable development in Dubai and the wider UAE.

The Centre is comprised of a team of very diverse leading UAE engineers, analysts and experts all working towards positioning the UAE as an internationally renowned leader within the field of science and technology. By developing new technology, expertise, and intellectual property, it is hoped that the UAE can emerge as a global front runner within the industry.

IAF Excellence in “3G” Diversity Award (Networking Lunch)



International Space Education Board (ISEB)

The ISEB Student Programme was held in Adelaide, Australia from 24-30 September 2017, as part of the International Astronautical Congress (IAC). The Student Programme was a big success, with a range of activities for ISEB students, as well as local students and educators. The ISEB, which includes nine partner agencies - Canadian Space Agency (CSA); European Space Agency (ESA); Japan Aerospace Exploration Agency (JAXA); National Aeronautics and Space Administration, NASA; Centre National d'Etudes Spatiales (CNES); Korea Aerospace Research Institute (KARI); South African National Space Agency (SANSA); Victorian Space Science Education Centre (VSSEC); and Mexican Space Agency (AEM) sponsored the Student Programme. Approximately 60 ISEB sponsored students participated. Students had the opportunity to present technical papers and interactive posters throughout the week, as well as hear from leaders in the space world and network with colleagues from around the globe. The North American Team, which included three NASA sponsored students placed in the Manford Law Moot Court Competition and ISEB students supported them, as much as possible.

The Student Zone was significantly larger than in the past, allowing the outreach to be even larger. Approximately 600 local

elementary school students participated in outreach activities on September 26, 27, and 28. There were two sessions per day, with 100 students per session. Staff from the VSSEC trained the ISEB students to serve as facilitators of the "Tickle My Droid" activity, which focused on coding and robotics. The ISZ was a place of "orderly chaos," as students and staff spent time together learning and having fun. Members from the ISEB and Space Education Outreach Committee (SEOC) worked together to promote a very successful student programme. Please see attached photos.



IAC Hosts Summit

– The Evolution and Legacy of IAC



What has been, and could be done, to the International Astronautical Congress (IAC) to further improve its impact on attendees and host nations was heard during the Hosts Summit. This provides a platform for past, current and future IAC holders to discuss ideas on how further to improve the congress.

The IAC has come a long way since the first congress in 1950 in Paris, France. However, as the nature of space activities change, IAC must evolve to remain important for everyone; regardless of location or organization, attendees were told by Jan Kolar, Chairman of IAC Evolution WG. The IAC has grown to provide many smaller and more in-depth sessions discussing issues related to space, such as the Global Networking Forums (GNF), which provides a more effective method of informing attendees. It was highlighted by the Co-Chair of IAC Organization Evolution WG, Geir Hovmork, how in previous years of IAC, the first two days were dedicated to discussing current space activities and plans of the US and the USSR. In today's interconnected world, these activities are being shown through digital means rather than in a conference. Clay Mowry, Chairman of IAC Finance Evolution WG and Co-Chair of the IAC Evolution Steering Group, reported how IAC 2017 has been the largest and most diverse in attending organizations and people with around 4,200 attendees from across the world. The considerable number of dynamic presentations has increased the value of attending IAC, which, as highlighted by Mary Snitch, Senior Manager at Lockheed Martin Corporation, has also become an important event for her company to attend due to the collaboration and networking benefits it provides.

Several items were suggested as possible areas of IAC improvement. Kolar spoke on how the strong drive to include youth and young professionals needs to continue to ensure the continuing success of not only IAC, but of space in general. The need to improve participation of IAC was discussed. This could be facilitated by increasing the amount of digital content that people could interact with, bringing IAC closer to the way many people consume information today. Additionally, further effort needs to be done to improve public awareness of conducted space activities and of the direct benefits that space can provide, especially to the developing world. The IAC could be in a unique position to provide leadership in this area.

The second session in the IAC Hosts Summit spoke of the legacy of the congress and its effect on host nations. Francisco Javier Mendieta, Director General of the Mexican Space Agency, spoke of how investment into space has boomed since IAC was held in Guadalajara, Mexico in 2016. Not only has the benefit been felt in manufacturing and research for space activities, the perception of space by the government has dramatically changed. Mendieta highlighted how the recent government investment into the use of space as a resource has seen significant use in the months leading up to IAC 2017, when Mexico experienced several devastating cyclones. Without the use of Earth Observation and telecommunication satellites to support the disaster relief effort, the impact of these events would have been far worse.

Brett Biddington, Chief Executive of IAC 2017 in Adelaide, spoke of the impacts he hoped IAC would bring to Australia. Currently, there is very little leadership in policy or direction for Australian space activities, which he hopes will change with the then would-be soon announcement of an Australian space agency. Biddington also highlighted how the current Australian space activities are fragmented due to a strong start-up company presence in the sector. Government has generally been slow to understand and provide what the market needs, which has been filled in by these companies.

The issue of how to even better involve people in IAC was discussed by several of the session panellists. Salem Al Marri, Assistant Director General at the Mohammed bin Rashid Space Centre and IAC 2020 Host Candidate, spoke of how they wish to improve the participation in space for the Middle East, especially as IAC has not yet been hosted by a nation in the Middle East. Marri spoke on how he saw there would be significant benefits to regional participation in space as well as providing an inspiration to the many youth living in that region of the world to participate in STEM fields of study. This sentiment was shared by Mendieta, who added that given the benefits that hosting IAC has provided to Mexico, IAC should aim at reflecting how space is something that all can participate in and not science-fiction, or an industry only for wealthy or developed nations.

8th International Meeting for Members of Parliaments (MoPs)

– Space Entrepreneurship and Socioeconomic Benefits

The International Meeting for Members of Parliaments (MoP) is an annual event held by the IAF in conjunction with the International Astronautical Congress. Parliamentarians from across the world have the opportunity to discuss matters of importance to the international space community with experts from space agencies, industry and academia. This year, space entrepreneurship and related socioeconomic benefits were discussed in a series of keynote speeches. This was followed by two themed discussion sessions on government policies for space business, and the transfer of technology from and into space.

The first keynote speaker was the Director General of the European Space Agency (ESA), Jan Woerner, who provided an overview of the paradigm shift in space activities, known as Space 4.0, and how entrepreneurial companies have been using this to succeed. Simonetta Di Pippo, Director of the United Nations Office for Outer Space Affairs (UNOOSA), discussed how dependent the world has become on space activities in our daily lives. To ensure that all of us can make use of this resource, UNOOSA is facilitating sustainable development with countries and industry through initiatives such as Space for Development Profile and Space Solutions Compendium. The CEO of Innovative Solutions in Space, Jeroen Rotteveel, reported on the growing use of smaller satellites using standardised “Earth-grade” components. Rotteveel also discussed how the space sector is becoming just another high-tech industry, where innovation is driven by market demand. The development of new launch systems was described by Ariane Cornell, Head of Astronaut Strategy and Sales at Blue Origin, who detailed the development of reusable rockets to lower launch costs of hardware into space. The last keynote speaker was Tytus Michalski, Managing Partner at Fresco Venture Capital, who spoke of how space industry development is being driven by its potential applications, customer discovery and user experience. Michalski also talked about how space is becoming more of a method of conducting business rather than a separate industry, using the example of

how organizations use the internet to provide their service, rather there being a separate ‘internet sector’ to provide these services.

In first discussion session, the MoP event heard how space agencies and industry conduct space activities. Ken Davidian, Director of Research at the Federal Aviation Administration Office of Commercial Space Transportation, spoke of how the space industry is segmented, where each segment has different characteristics and are at different stages in their development maturity. Time frames for space activities are often in decades rather than years, and as such, they need continuous support from successive governments. The transition from government-led to industry-led activities was discussed. Lionel Baize, Space Exploration Manager at CNES, spoke of how his space agency has conducted outsourcing of technology development to private companies, facilitated by CNES. Baize also spoke of how the space sector needs to work with downstream users to understand market needs, through methods such as providing network and expertise links or funding.

The second discussion session heard how companies have been using space to provide direct benefits to Earth in the new paradigm of Space 4.0, specifically in the areas of Earth Observation and Internet of Things (IoT). Small start-up companies are often more able to adapt and explore new development areas in space. Both Alex Grant, CEO of Myriota, and Flavia Tata Nardini, CEO of Fleet discussed how their companies are planning to provide IoT capability to normally-mundane hardware to provide around-the-world communication and control capability. Frank Salzgeber, Head of Technology Transfer and Business Incubation Office at ESA, spoke of the many innovation and incubation centres across Europe. He described how organizations need to be less risk adverse; especially those who are more capable of absorbing any potentially negative results, such as government-funded space agencies.



IAF Committees' Reports

TECHNICAL COMMITTEES

Earth Observation Committee (EO) and GEOSS Subcommittee

The Earth Observation (EO) Committee and the Global Earth Observing System of Systems Subcommittee (GEOSS) focus is on Systems, Technologies, and Applications for Earth Observations. Membership of the Committee and Subcommittee stayed stable. Many friends joined the committee throughout the year to help create and produce a robust set of technical sessions and a very engaging and successful “Earth Day” focus for Thursday, 28 September at the 68th IAC in Adelaide.

To represent the many remarkable changes underway in Earth Observations due to the advent of Big Data, Citizen Science, and Climate Change, along with the many advances in Earth Observing systems, the

session covered viewpoints from the Global Partnership for Sustainable Development, Geoscience Australia, and the companies Amazon Web Services, and Sinergise. This expert panel spoke to how earth observations can support the UN Sustainable Development Goals, new “data cube” technologies applied by Australia can unlock the value of earth observations, and large and small “big data” businesses that can help accelerate the use of EO for sustainable development. This was followed by a special technical session on big data technologies applied to earth observations.

The next major event sponsored by the committee was the Kick-Off event for a three year partnership between the GEOSS subcommittee and Young Professionals Programmes about the role of Citizen Science in Earth Observations. The was moderated by a member of the Young Professionals Programmes, included two members of the GEOSS subcommittee, and an Australian resident expert. The panel brought out many points on the incorporation of citizen science data in scientific investigations, but also for its use as an educational and public engagement tool.

This was followed by ESA and JAXA sponsored Global Networking Forums on related topics in parallel with a second Earth Observations technical session. The last event of the day was an outstanding Highlight Lecture by Dr. Paul Hardisty, the new Chief Executive Officer



GEOSS subcommittee on behalf of the EO committee, spearheaded several unique programmes. In close cooperation with the Commission and Local Organizing Committee, a full day of Plenary, Global Networking Forum, Highlight Lecture and technical programmes addressed these key topics. Strong Australian participation throughout made them special and highlighted the key role Australian developments apply globally to Earth Observations.

This “Earth Day” started with “From Up There to Down Here, Big Space Data Driving Sustainable Development and Economic Growth on Earth.” This well attended panel



of the Australian Institute of Marine Science. He was introduced by JAXA Astronaut, Chaiki Mukai, who briefly spoke about how special the vantage point of space is for appreciating Earth's many natural wonders. Dr. Hardisty's talk began with the wonder, beauty and value of the reefs. He then gave striking data and images of the recent extensive damage from the unprecedented multi-year bleaching events. He showed how satellite observations are making a real difference in better understanding of the conditions surrounding bleaching, and monitoring health of the reefs and their surrounding ecosystem. He finished talking about the work being done to develop measures that might mitigate damage, make the reefs more resistant, and protect them from the bleaching conditions. Dr. Hardisty then took several audience questions and was gracious enough to entertain further questioning after the lecture was over. He and his message clearly struck a chord with many in the audience, and capped off a very successful day of Earth Observations.

One other noteworthy highlight during the Adelaide IAC, the leadoff EO B.1.1 session featured an invited paper by the Committee on Earth Observation Satellites (CEOS) Chair. During the Adelaide Committee and Subcommittee meetings, a major focus was on preparing robust technical sessions, and preparing proposals for highlight lecture and plenary sessions, for both Bremen and Washington. Brainstorming for these starting at the IAF Spring Meetings in 2017. In Adelaide, the discussions focused down on 5 main ideas. Teams were formed to pursue each of the ideas. Between the Spring Meeting and the Adelaide meeting, EO committee held a teleconference, to status preparations for Adelaide, discuss developments for Bremen, and exchange IAF news.

A major aspect of the planning was to prepare for the

second year of the three year Young Professionals Programmes, partnership on Citizen Science. A follow-up meeting was held during the conference in Adelaide with YPP to plan a joint Global Technical Session for Bremen, and based on that plan, the call for papers was drafted and submitted for what will be the EO B.1.6 session. A second major aspect was to take advantage of Bremen to try some innovative ideas to bring EO to a broader audience at the conference. The EO committee and the GEOSS subcommittee will be working on these ideas with the local organizing committee.

In addition to preparing sessions, and proposals for lectures and plenaries, the Committee also discussed how to expand "3G" diversity and organizational diversity to attract representatives of new space organizations. Several ideas were brought up, and will be pursued.



The committee also addressed the new rules on terms of Chairs and members. One new member candidate was introduced at the EO committee meeting in Adelaide.

Committee on Integrated Applications

This report summarizes the outcome and main messages from the meetings and sessions related to Integrated Applications during the International Astronautical Congress 2017, which took place in Adelaide, Australia, 25 – 29 September 2017.

Integrated Applications Technical Committee

The Integrated Applications Technical Committee met on Wednesday, 27th September 2017, to discuss the

progress of the Integrated Applications Symposium. The meeting was chaired by R. Mugellesi and provided the opportunity to discuss current status of the Symposium and next steps.

The Committee concluded on the following main points:

- Given the large amount of proposed contributions to the symposium for IAC2017, about the double of what could be accommodated in the two sessions, a strategy has to be devised in accordance with IAF management on how to deal with it. Several options

were discussed, where one option would be to create an extra session for IAC2019.

- There has been during the years an increase in the effort required for the management of the symposium and sessions, including the selection of the papers, preparation of the announcement for the subsequent year, preparation of the contribution to IAF Highlights Journal, chairing the sessions and prepare the related documents. The committee discussed that a committed and continuous support is required for these tasks. It was decided to review the membership list and ask confirmation of the commitment from the members.
- The Integrated Applications Technical Committee will begin the process of formulating future plans for the 2018 Global Space Applications Conference to be held in Montevideo, 21-23 May 2018, as well as the future instances of the International Astronautical Congress, scheduled for Bremen, Germany in 2018.
- The proposal of the Chinese delegation of setting up a session under the umbrella of the B.5 Symposium entitled B5.3. "Small Satellites Commercial Applications", starting with IAC2018 did not take place due to the lack of support of the Chinese delegation. The action is to contact IAF Secretariat and investigate the presence of B5.3 for IAC2019 provided the required support from China Space Agency is given.



The Integrated Applications Technical Committee

Session B4.4: Small Earth Observation Missions

This session is part of the Small Satellite Missions Symposium. This Symposium, organized by the International Academy of Astronautics (IAA), addresses small satellite missions and projects in science, exploration, and technology for government, industry, and academic programmes. This session addresses the technologies, applications and missions achieved through the use of small, cost-effective satellites to observe the Earth and near-Earth space. The session took place on 27th September 2017 and was chaired by R. Mugellesi and L. Paxton, from the Johns Hopkins University Applied Physics Laboratory, United States.

The papers covered a variety of missions from different countries and some relevant ones are described below:

- **Technological Experiments on the DLR -BIROS Satellite for the Next Generation of Earth Observation Missions**, presented by DLR, Institute of Optical Sensor Systems, Germany
The German BIROS Satellite (Bispectral InfraRed Optical System) is based on DLR proven technology gained during the BIRD mission, which was launched in 2001 and was primarily used for observation of fires and volcanic activity until 2004. Together with the TET-1 Satellite (launched in 2012) BIROS (launched in 2016) is a part of a two-satellite-constellation "FIREBIRD" especially for active fire observation. The talk focused on BIROS new technological experiments for the next generation of remote sensing satellites.
- **The Case for Video Imaging from Space**, presented by SSTL, UK
Imagery has still a number of limitations in applications related to surveillance, disaster monitoring and news gathering. Video imaging systems have been demonstrated several times over the past decades, but single spacecraft are limited in application as they cannot cover specific target areas on the globe frequently enough. Furthermore, previous video imaging missions have generally lacked the necessary resolution to allow fine scale human activity to be monitored, such as traffic and crowds. Small satellites have now matured to the point where high resolution video imaging is feasible. Over the past years SSTL has been developing such video imaging mission prototypes, with the launch of Carbonite1, and the launch of Carbonite 2 in 2017. The talk presented lessons learned from these missions and the development of video image processing techniques at SSTL.
- **Design Considerations in rapid-revisit Small Satellite Constellations**, presented by SSTL, UK.
Earth observation satellites provide an invaluable supply of imagery for a range of applications. However most current systems consist of a single satellite, or a small constellation, which imposes a number of limitations including restricted coverage and limited revisit. The common use of sun-synchronous orbits for optical imaging satellites also means that passes are highly predictable and limited to a narrow time band each day. A moderately sized constellation of small, low cost optical satellites, providing high resolution imagery and operating in a low inclination orbit in multiple planes, can provide frequent imaging to key areas of interest throughout the day allowing information updates with timeliness of the order of minutes. Coupled with a supporting ground and communications architecture which maximises the responsiveness of the system



Co-Chairs of the B4.4 Technical Session

(minimising the total latency from image tasking to product delivery) enables applications including tracking and monitoring, change detection, pattern of life assessments and support to humanitarian or disaster operations. The presentation focused on the benefits and issues associated with deploying and operating a constellation of imaging satellites and describes several viable design concepts currently undergoing in SSTL, including a Rapid Revisit Constellation.

- **FireSat; A UK South African Partnership and a Novel Approach to Wildfire Detection in the Southern African Region**, presented by Clyde Space, UK.
This presentation discussed the FireSat nano-satellite Earth Observation constellation, which will deliver a space-based Earth Observation system to detect wild fires in Southern Africa. The FireSat platform incorporates a novel means of detecting fires from Low Earth Orbit using an imaging payload, developed by the Council for Scientific and Industrial Research in South Africa, to detect potassium released by the burning of biomass during fire events. This project will therefore generate a means of performing space-based remote sensing for enhanced and timely detection of wild fires using low-cost nanosatellite technology. The data generated by the FireSat platforms will be integrated with the Advanced Fire Information System, an application to disseminate vital fire warnings to users and fire management teams through web viewers, mobile applications, SMS and email alerts to allow a quick response to extinguish the fire and reduce the impact of these events.

Session B5.1: Tools & Technology in Support of Integrated Applications

The Session took place on 29th September 2016 and was chaired by R. Mugellesi and B. Penne, OHB, Germany. The session focused on specific systems, tools and technology in support of integrated applications and addressed the various issues associated with the design of space and ground systems, the kind of data they collect, how they collect data, and how the data are integrated and distributed to address key user needs. Some relevant papers of the session are described below.

- **Business Case Development for Precision Agriculture Applications using UAV and Space Borne Platforms**, presented by Ecole Polytechnique Federal of Lausanne, Switzerland.

The work proposed to utilize hyperspectral imaging (HSI) technology to monitor agricultural surfaces for disease identification at early stages of their development. Based on crop damaging factors and the ability of visual identification, six most harmful diseases were studied. Literature research showed that spatial resolution better than 1 meter is required to monitor the diseases at early stage. Revisit time should be smaller than 5 days and spectral bands should be in range from 400 to 1100 nm. Near-ground drone, stratospheric drone, small satellite constellation and large satellite were studied as potential carriers. The goal of this presentation was to prepare a sustainable business case for disease monitoring. The near-ground drones (NGD) showed to be beneficial for farms up to 30000 ha, while stratospheric drones better to be used on larger territories. Cost analysis demonstrated a substantial increase of economic profitability for detection of earlier illnesses.

- **Space capabilities for maritime surveillance: myth, or reality of the future?** presented by TAS, France.

This presentation focused on the Maritime Domain Awareness Missions, the varied challenges in maritime surveillance, the way space is used today and the different space solutions that can fulfil these requirements with other capabilities. The presentation was an interesting overview of the state-of-art of these missions and looked also to aspects as the user community, the complementarity between radar satellites and optical satellites, and the added values of each system.

- **The Future of IoT and its Applicability to Space and Energy**, presented by ISU, France.

The presentation explored the future of the Internet of Things (IoT) and its applicability to both human and robotic, local and remote operations in the energy and space industries. These IoT devices are primarily Internetconnected sensors used to provide data about their surrounding environments. Through deployment of automated monitoring systems across major facilities, oil and gas companies are enabled to leverage IoT analytics to improve business and enhance process safety. This study looked at four sectors: energy, Earth observation, remote platforms, and future space endeavors. Within each of these domains, the current mode of operations and how the application of IoT can increase efficiency, reduce cost, and improve human safety with an emphasis on the extraction, distribution, and transmission of energy was addressed.

Session B5.2: Integrated Applications End-to-End Solutions

The session is a forum for end-to-end solutions, including case studies, proof-of-concept missions, and current projects that provide, or could provide, innovative user-driven solutions. Applications that combine ground- and space-based data sources with models to address specific user requirements were presented. These examples covered a variety of domains, like disaster/crisis monitoring and management, energy, food security, space situational awareness, transportation, health, etc. The Session took place on 29th September 2016 and was chaired by R. Mugellesi and B. Penne. Some relevant papers of the session are described below:

- **How can Sentinel-2 images assist humanitarian actions to help reduce calamities on the sea**, presented by Department of Remote Sensing, Institute of Anthropological and Spatial studies, Research Centre of the Slovenian Academy of Sciences and Arts, Ljubljana, Slovenia.

The process of migration by sea is often accompanied by a great deal of risk for the migrants. The need for reliable and on time information on migrant movements is essential, especially as the available information is often limited or inconsistent. The aim of the presentation was to show how freely available Sentinel-2 optical images over large areas could support humanitarian actions with timely and accurate geospatial information by providing exact location of vessels on the sea at the time of satellite acquisition. The proposed detection method could provide a better understanding of the situation for the authorities. Using Sentinel-2 data, an automatic vessel detection and classification procedure has been developed. The results also demonstrated that the methodology gave reliable outcome in a timely and consistent manner.

- **HAVOC – High Altitude Vehicle Observations Constellation: An Innovative Approach to Guarding Frontiers**, presented by Johns Hopkins University Applied Physics Laboratory, USA.

A study of a new concept for using small satellites and autonomous airborne platforms for Earth observation was proposed. There are many challenges associated with observations from space including coverage and persistence. Rather than provide a space-only solution, it has been examined a different concept including satellites, high altitude balloons, high altitude unmanned aerial systems (HALE UAS) to drive down cost, increase responsiveness, and provide a new capability for dynamic observations such as persistent tracking in poor weather, including shipping in the Arctic. HAVOC is a disaggregated, inhomogeneous constellation of stratospheric and space sensors utilizing communications technologies that solve complex surveillance and even border protection

issues. For this study, tracking of Arctic shipping was used. The Arctic is a region that is becoming more accessible as the area of summer polar ice decreases and as the thickness of the winter ice diminishes as well. While small Earth observing satellites have an important role, their value may be augmented by adding UAS and other ground based sensors to the space solution.

- **SAFIY: Feature Extraction using High Resolution Satellite Imagery for UAE**, presented by United Arab Emirates.

Over the past decades, the United Arab Emirates has experienced rapid growth in both development and population. Hence, there has been a necessity to constantly monitor these fast paced changes. As technology is evolving day by day, there is a possibility to monitor changes that are happening on different areas using satellite imagery. The data from these imageries can be utilized to identify and extract different features, such as water areas, vegetation areas, and roads, which will aid the municipal planning and management, and environment authorities. Through this data, road constructions, water resources, and vegetation growth in various areas could be monitored. The presentation showed how these features can be detected and extracted through SAFIY (i.e. the Smart Application for Feature extraction and 3D modelling using high resolution satellite Imagery) by using high-resolution satellite imagery from DubaiSat-2 and Deimos-2 (0.75m resolution), and WorldView-3 (0.3m resolution) satellites. In addition, SAFIY is able to detect different vegetation types, specifically palm trees and mangroves.

- **The Rise of Drones: Analysis of Current and Future Applications of Drones in Terrestrial Remote Sensing**, presented by ISU, France.

The presentation aimed to assess the potential benefits of drones in terrestrial remote sensing. Drones can cooperate, complement, or replace satellites in climate studies, resource management and disaster management respectively. In comparison, drone market trends are showing an uptake over satellites in all three remote sensing fields, but specifically precision agriculture within resource management and local meteorology within climate studies. Additionally, the drone industry is polarizing into a monopoly manufacturer and a rapidly growing drone services market, the latter being the recommended space for entrant companies. There are currently no international regulations for drone operations, thus unification of drone laws, standardization of drone categories, and obligation for registration coupled with strict manufacturing control have been recommended. Implementing such measures would address safety, security, privacy and public liability issues.



Global Workforce Development Subcommittee

Introduction

- The Global Workforce Development Technical Subcommittee is responsible for **promoting the development of the worldwide space community in order to foster a highly skilled and motivated workforce**, with a special focus on **attracting and retaining high caliber and talented young people** to face the global challenges of tomorrow.
- The Terms of Reference** of the committee are established in line with the Guidelines established by the IAF Bureau.

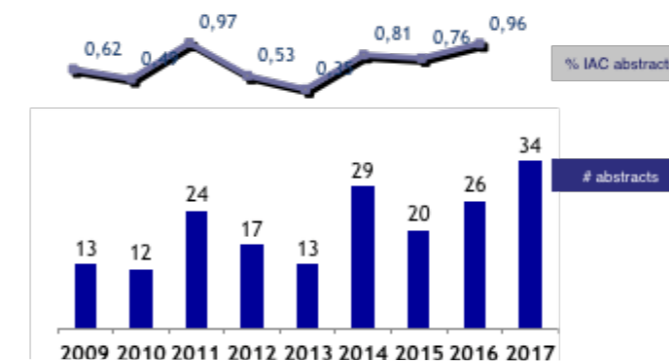
Membership status

- Members are nominated by the Space Education and Outreach Committee (SEOC) and by the Workforce Development / Young Professionals Programme Committee (WD/YPP) and approved by their respective chairs.
- The Technical Subcommittee reports to SEOC and WD/YPP and is chaired by a member of one of these committees, who are nominated for a term of 3 years by the SEOC and WP/YPP chairs.

Name	Role	Affiliation	Since	Country
Monzon, Amalio	Chair	Airbus	2009	Spain
Zhdanovich, Olga	Vice Chair	European Space Agency	2009	Netherlands
Matthews, Mabel	Member	NASA	2009	United States
Meusy, Nathalie	Member	European Space Agency	2009	France
Edgington, Stacey	Member	NASA	2009	United States
Friedlander, Frank	Member	Lockheed Martin	2009	United States
Kessler, Claudia	Member	HE Space	2009	Germany
Welch, Chris	Member	International Space University	2009	France
Wigbels, Lyn	Member	American Astronautical Society	2009	United States
Mayorova, Vera	Member	Bauman State Technical University	2009	Russia
Thompson, Lachlan	Member	Melbourne Institute of Technology	2009	Australia
Weigel, Annalisa	Member	Massachusetts Institute of Technology	2009	United States

Activities and session at IAC 2017

- The Global Workforce Development Subcommittee manages a dedicated technical session of the Space Education and Outreach Symposium since 2009.
- The Sub-Committee collaborates with International Project/Programme Management Committee (IPMC) in its purpose of exchanging information, discussing mutual activities and sharing best practices for enhancing the management of space programmes and projects. Within this framework the Workforce Development technical session is chaired by the IPMC once every two years.
- The abstracts since 2009 show a positive trend in terms of absolute and relative volume as well as an interest from a diverse range of actors in the sector, such as space agencies, industry and academia.



- The technical session held in the IAC 2017 (E1.5 Enabling the Future - Developing the Space Workforce, which focused on the challenges, opportunities and innovative approaches to developing the current and future global space workforce) was specially successful due to the following facts:
 - Year with more abstracts received since the creation of the session in 2009.
 - Session with more abstracts received in the Space Education and Outreach Symposium - E1.
 - Second Technical Session with more abstracts received in the Category Space and Society - E.
 - Very good geographical distribution with abstracts from Americas, Europe, Africa, Asia and Oceania.

Other activities

- With the occasion of the 10th anniversary of the session in the next IAC 2018, the Global Workforce Development Subcommittee is working in a study which aims to show the key trends and insights of this Technical Session since 2009.



Knowledge Management Technical Committee (KMTC)

In the today's digital era, also space businesses should rethink on the KM approaches to generate a community of shared and useful information and knowledge. More advanced technologies give digital workers the opportunity to communicate and collaborate on a regular basis. In addition, the proliferation of mobile devices and social media allows content to be more rapidly shared. This new environment pushes towards understanding what critical knowledge is, how it can help drive down costs and seeing solutions.

Key themes addressed during the committee meeting and session were: managing the sharing of the knowledge to develop new projects, what solutions should be in place to work securely across corporate and international boundaries, how is knowledge captured, shared, and used to drive innovation and create value to the organization, collaboration and culture, the financial value of KM to the business, processes and technologies that Organizations are using to sustain, energise and invigorate their ability to learn, innovate, and share knowledge. Examples of case studies of particular interest include successful projects and innovations in the application of knowledge management, grounded research in knowledge and risk management, methods that allow data, information or knowledge exchange within or amongst Organizations in support of actual programmes.

The Knowledge Management Technical Committee met at IAC2017 on Wednesday, 28th September 2017 and was chaired by R. Mugellesi Dow, ESA, and L. Baize, CNES. The Committee acknowledged the recent developments on KM achieved by the individual organizations and focused the discussion on the activities supported by the Committee. In 2017, the committee organized the International Knowledge Management Workshop held on the premises of DLR, Germany, June 2017. This Workshop was the continuation of the International KM Conferences organized in previous years by the Committee in NASA, ESA and CNES. The committee also discussed the progress of the working group on "Model Based Systems Engineering (MBSE)" and in particular the liaison with the "System Committee".

At IAC2017 the Knowledge Management Technical Committee organized and chaired the technical session D5.2 entitled "Knowledge Management & Collaboration in Space Activities". The session comprised some fascinating insights into various proposed knowledge management techniques. Some of the most novel ideas are covered here.



The Committee during the session D5.2. From right, Lionel Baize, CNES, Roberta Mugellesi, ESA, Patrick Hambloch, University of Alabama USA.

Interesting was the paper entitled "Space Mission Design supported by Knowledge Based Systems: Autonomous Decision Making in Early Design Phases" which analysed the applications of fuzzy case based reasoning and proposed a design methodology which considers a merge between knowledge based systems and uncertain reasoning to support and automate concurrent space mission design. In particular, the benefits of this methodology within an academic concurrent design facility were underlined, highlighting the additional challenges in an academic environment that is possible to overcome, such as short learning curve or intensive team turnover. Thanks to a CubeSat case study, the benefits given by these tools were then globally analyzed and a roadmap for a totally autonomous preliminary design was structured, proving the capabilities and future development of this artificial intelligence tool within aerospace systems design.

The paper "Risk and Knowledge Management at ESA" looked at the relationships existing between risk and knowledge management processes at ESA. The aim was to analyze how Enterprise Risk Management as well as programme/project related Risk Management processes may be supported by Knowledge Management practices currently in place and vice versa. This paper compared the commonalities between the Risk and Knowledge Management functions and tasks to identify common areas of influence. For example, risk identification may be supported by already collected project lessons learned or by locating a subject matter expert. Likewise, risks, which have been mitigated, may be considered candidates for knowledge capture and sharing opportunities across the whole Agency. Within

the risk management process applicable to the ESA programmes/projects and at Agency level, the network of risk coordinators provides an efficient channel for the sharing of risk-based knowledge. Specifically, the analysis aimed at identifying those Knowledge Management processes that could influence positively future risk assessments, impact the decisions on mitigation actions to be taken and future controls to be applied. For example, when risk mitigation actions and decisions have been implemented, the sharing of such information between different layers and groups at ESA, will develop awareness among all the players and may constitute warning signals within the Risk Management process. Putting knowledge to work in the context of Risk Management is likely to have positive effects on mitigating risks at ESA.

The paper "Space Mission Collaboration for the Benefit of Humanity" tackled other aspects related to knowledge Management describing the importance of developing

a social collaboration platform to allow people around the world to plan, design and execute space missions together. Using the platform, people can self-organize into virtual or local working groups with the tools necessary for seamless cross-collaboration. These tools include project management, data analysis, as well as crowdsourcing and crowdfunding. The platform could enable individuals or groups to join a project and begin collaborating immediately, regardless of geographic distance. Individuals will be empowered to cooperate to propose and implement projects on a scale currently reserved for only the largest corporations. With an open framework to collaborate on space missions made easily available to everyone, independent problem-solving communities can organically emerge. These problem-solving cells can leverage the abilities of thousands of like-minded individuals and finally will spread the notion that if you have a grand dream, your first step to collaborating towards its realization is just a mouse click away!

Materials and Structures Committee

The Materials and Structures Committee of IAF was established more than thirty years ago by Prof. Paolo Santini. Its task is the promotion of the world-class research and the latest technological achievements in the design, development, verification and utilization of space structures and components, of their materials and the structural dynamics behaviour under different environmental conditions. During the years the topics addressed by the Committee have evolved following technological progresses and innovations both in the use of new materials for space structure components but also in the use sophisticated mathematical and numerical modelling techniques. The rapid evolution in space engineering, that includes now a more

strictly combination of mechanics, materials, and electronics and of course computer engineering, requires to develop new non-conventional design processes. Materials and Structures Committee follows this evolution and through the symposium, which annually sees the submissions of more than 200 abstracts,



The award ceremony

makes a virtual bridge among the scientists and specialists around the world for a better integration of the new technological challenges. The symposium is grouped into nine sessions plus one interactive poster session. Actually Materials and Structures Committee is made up of about 40 members, among which more than 30 are strictly involved in the annual organization of the IAC conference (i.e. they both participate at the spring and the fall TC's meeting as chairs and rapporteurs). The rest of the members participate at the Material and Structure Symposium and give a substantial support during the annual conference in terms of the overall general organization. During the meeting in Adelaide the Committee also discussed ideas for the IAC2018 in Bremen, Germany. Paolo Gasbarri, Chair of the Committee, talked about some inputs he received in the last months from scientists involved



Dr. Suraj P. Rawal, recipient of the VII Paolo Santini Memorial Lecture



Materials and Structures Committee during the meeting in Adelaide, Part I (serious staff)

in developing automatic and autonomous systems for space explorations. The request for new methodologies for the structural and mechanical design of space robotic systems and manipulators requires the use of advance materials and rapid prototyping techniques together with a more integration of the tools and the processes currently in use for design and test. M&S Committee will monitor these topics in the near future and eventually will bring them into the Symposium.

In 2011 M&S Committee established the annual Paolo Santini Memorial Lecture dedicated to the memory of Professor Paolo Santini who died in June 2006. Paolo Santini, Emeritus of La Sapienza, was one of the outstanding personalities within IAF and the IAA for almost 40 years. He was a man of great scientific knowledge, talents, prestige and great cultural influence, a perpetual source of power and ideas

within international aero-space community (IAF, AVT-RTO, AGARD and ICAS).

In 2017 the recipient of the award was Dr. Suraj P. Rawal, from the Advanced Technology Centre of the Lockheed Martin Space Systems Company, who gave an outstanding Keynote Lecture titled “Materials and Structures Technology insertion into Spacecraft Systems: Successes and Challenges”.

It is worth also to mention that this year, during the last section of the Symposium titled “Advancements in Materials Applications and Rapid Prototyping”, Dr. Raymond G. Clinton from NASA Marshall Space Flight Center presented a Key Note Speech on “NASA Additive Manufacturing Initiatives: In Space Manufacturing and Rocket Engines”. Dr. Clinton was also asked to enter the Committee.



Materials and Structures Committee Meeting in Adelaide, Part II (fun staff)



Select Sub-Committee on Satellite Applications

Meeting of Official Establishment of the IAF Select Sub-Committee on Satellite Commercial Applications and the Opening of the Sub-Committee’s Asian Pacific Office in Hong Kong

On the occasion of the 20th anniversary of Hongkong’s return to China, the International Astronautical Federation (IAF) and the Chinese Society of Astronautics (CSA) jointly held the meeting of Official Establishment of the IAF Select Sub-Committee on Satellite Commercial Applications (the Committee) and the Opening of the Sub-Committee’s Asian Pacific Office in Hong Kong, the beautiful Pearl of the Orient, on June 29, 2017.

Over 100 representatives from the Liaison Office of the Central People’s Government in the Hongkong S.A.R, China Association of Science and Technology, China Aerospace Science and Technology Corporation, China Astronauts Research and Training Center, universities and business in Hongkong were invited to attend the event.



Over 100 representatives attended the Official Establishment Meeting of the IAF Select Sub-Committee on Satellite Commercial Applications and the Opening of the Committee’s Asian Pacific Office

Mr. WANG Yiran, the vice president and secretary general of CSA moderated the event. Mr. XU Yanhao, Executive Secretary of China Association of Science and Technology (CAST), Mr. ZHANG Jianheng, vice president of China Aerospace Science and Technology Corporation (CASC), Dr. Christian Feichtinger Executive Director of IAF, Prof. Otto Koudelka, Vice President of IAF, Prof. John Horack, Special Advisor of IAF President and Co-Chair of the Committee delivered speeches.

Mr. XU Yanhao, Executive Secretary of CAST, pointed out in his speech, that the cooperation between IAF and CSA has promoted China’s space professionals’ communication and exchanges with the world colleagues, prospered the academic atmosphere and pushed forward the development of space science and technology. IAF/

CSA cooperation is one of the successful experiences that deserves to be learnt by the 210 society members of CAST. CAST will continue to support rigorously CSA and IAF to carry out widespread exchanges and cooperation at multilevel and with manifold channels to make space technology benefit mankind.



XU Yanhao, Executive Secretary of China Association of Science and Technology

Mr. ZHANG Jianheng, the vice president of China Aerospace Science and Technology (CASC), said in his speech, that CASC is the presidential level member of CSA and is active at supporting and promoting the international exchange and cooperation. CASC has supported the experts from its subsidiary academies and institutes to be member of the Sub-Committee. They will work together with scholars, experts and entrepreneurs from all over the world to study and research the major issues of satellite commercial applications, promote academic exchanges and international cooperation, and push forward the standardized development of satellite commercial applications. CASC is willing to carry out deep exchanges and wide cooperation with world space companies with the platform built by IAF to share the results of space technology for the purpose of serving people better.



ZHANG Jianheng, the Vice President of China Aerospace Science and Technology



WANG Yiran, the Vice President and Secretary General of CSA, moderator of the event

Dr. Christian Feichtinger, Executive Director of IAF, introduced to the representatives the development history of IAF, its activities, the strategic partnership between IAF and CSA, and IAF's long-term and good cooperation with China's space community built through CSA.



Christian Feichtinger, Executive Director of IAF

Prof. Otto Koudelka, Vice President of IAF, and Prof. John Horack, Special Advisor of IAF President and Co-Chair of the Committee on emphasized separately the importance and meaning of establishing the Committee and opening of its Asian Pacific office from the point view of the technology development of satellite commercial application and global space cooperation.



Otto Koudelka, Vice President of IAF, and John Horack, Special Advisor of IAF president and Co-Chair of the Sub-Committee deliver speeches separately



With witness of the representatives, Mr. XU Yanhao, Executive Secretary of CAST, and Dr. Christian Feichtinger, Executive Director of IAF, unveiled the establishment of the Sub-Committee.

Mr. TAN Tieniu, the deputy director of the Liaison Office of the Central People's Government in the Hong Kong S.A.R, Mr. YU Dengyun, Vice Director of Scientific and Technological Committee of CAST and Vice President of IAF, Co-Chairs of the Committee, and Prof. John Horack, special adviser of IAF President and Co-Chair of the Sub-Committee presented the plaque of Asian Pacific office to the local staff.



XU Yanhao, Executive Secretary of CAST, and Christian Feichtinger, Executive Director of IAF, unveiled the establishment of the Committee



Presentation of the plaque to the local staff

IAF is the famous NGO of world space community. In 1980, with the approval by the Chinese government, CSA became one of the IAF Members. The two sides have maintained long term and friendly relationship with jointly organizing large academic conferences in China for four times. To deepen the cooperation, IAF supported and approved CSA's initiative of establishing

IAF Select Sub-Committee on Satellite Commercial Applications in September 2016. After nearly 10 months of preparation, IAF and CSA jointly held the meeting of Official Establishment of the Sub-Committee and the Opening of the Sub-Committee's Asian Pacific Office in Hongkong. The Sub-Committee is aimed to promote the international cooperation of satellite commercial applications, and push forward the development of global satellite commercial applications. The setting up of Asia Pacific office in Hong Kong, shows that IAF, as the international academic organization, pays strong attention to the development of satellite commercial applications. At the same time, it is a joint effort of IAF and CSA to promote the regional integration of academy, application and commercialization.

IAF Vice President Sergey Krikalev Visits Asia Pacific Office of IAF Select Sub-Committee on Satellite Commercial Applications

Vice President of IAF and Executive Director of Human Space flights at Roscosmos, Mr. Sergey Krikalev visited Asia Pacific Office of IAF Select Sub-Committee on Satellite Commercial Applications in Hong Kong on 22 November.

Accompanied by Mrs. Elena Feichtinger, Project Manager and Special Advisor of IAF, Mr. Krikalev investigated the Asia Pacific Office, and met with the branch team. Ms. Linqi ZHU, Director of the Asia

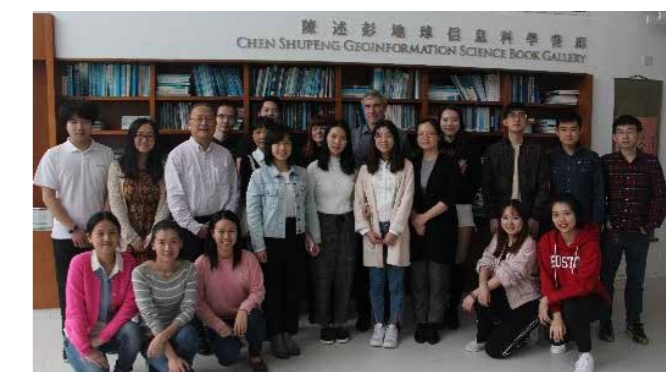


IAF Vice President Sergey Krikalev visits Asia Pacific Office

Pacific Office, briefed on the process of office launch, and its recent activities & operation.

Asia Pacific Office of IAF Select Sub-Committee on Satellite Commercial Applications was set up by IAF and Chinese Society of Astronautics (CSA). Focused on Asia Pacific region, the office is responsible for promoting satellite commercial applications, and advancing utilization and economic return from satellite commercial applications. Since launched at the end of June, the Asia Pacific Office cooperates with large state-owned enterprises to explore opportunities for landing satellite applications overseas. The office also organized international exhibitions and forums on satellite applications and services. Mr. Krikalev believes that following the path of combining international aerospace technology resources with local economic & social development is not only conducive to academic sustainability, but also to the benefit of human well-being. He provided some advice and requirements for future work of the office under the guidance of the IAF.

The Asia Pacific Office also arranged a visit to Chinese University of Hong Kong. Guided by Professor Hui LIN, Director of Institute of Space and Earth Information Science (ISEIS), Mr. Sergey Krikalev, Mrs. Elena Feichtinger, and Ms. Linqi ZHU visited the Laboratory for GeoInformation Science and Satellite Remote Sensing Receiving Station. After Professor LIN introduced background and achievements of ISEIS, they discussed potential cooperation, and reached a consensus on deepening the academic exchanges between IAF Members and local universities.





Space Astronomy Technical Committee (SATC)

Committee Meetings

The Space Astronomy Technical Committee (SATC, 2015–2018) held a face-to-face committee meeting on Saturday, 23 September 2017, at the Adelaide Convention Centre, prior to the 68th IAC.

The agenda included key topics:

- Current events in space astronomy, particularly the new area opened by the first correlated observations of EM and gravitational-wave signals
- Membership campaign for the committee, particularly the continued focus on industrial members and international agencies. SATC requests that other TCs and committees throughout IAF use their personal contacts to drive global industry and agency participation toward us.
- Annual activities, including report submission, next year's election, and recommitting the technical committee within IAF.

The SATC held a Webex meeting on 3 November 2017, to discuss this report.

Committee Participation in the 68th IAC

The SATC organizes and hosts Symposium A7, the **Symposium on Future Space Astronomy and Solar-System Science Missions**.

This symposium invites leaders throughout the science, space industry, and space-agencies communities to share with each other their respective activities, insights, and planning for future space missions in space physics, fundamental physics, astronomy, exoplanets, and planetary science on extreme frontiers in our solar system like Venus, Mercury, and the outer solar system including the Ocean Worlds.

Our symposia comprise both invited talks and contributed papers in these five areas: space physics, fundamental physics, astronomy, exoplanets, and planetary science on extreme frontiers. We solicit discussion of phenomena coming within our reach in the next half-century:

- Enabling measurement and system technologies, including significant progress made by research laboratories within industry and agencies,

- Mission concepts to implement such investigations,
- Corporate and space agency strategies for prioritizing and investing to make them real.

We trace this thread, from strategy to emergent technologies, throughout the week at each IAC, typically in three oral sessions plus IP, co-chaired and reported by committee members.

IPC members

Co-Chair: Dr. Jakob van Zyl, Jet Propulsion Laboratory, NASA, United States

Co-Chair: Prof. Pietro Ubertini, INAF, Italy

Co-Chair: Mr. Brent Sherwood, Jet Propulsion Laboratory, NASA, United States

Co-Chair: Dr. Eric Wille, ESTEC, The Netherlands

Session descriptions in the call for papers

A7.1: Space Agency Strategies and Plans

Invited talks by international space-agency division directors about their long-term views, priorities, and plans to implement developments and missions for the five fields (space astronomy, space physics, fundamental physics, exoplanets, and extreme planetary science). Mission scope includes flagship-class, large-class, medium class, small-class, and smallsat platforms. Programme scope includes status updates on current programmes, near-term investment priorities, and long-range directions, including the relationship to community and guiding research panels.

A7.2: Science Goals and Drivers for Future Exoplanet, Space Astronomy, Physics, and Outer Solar System Science Missions

Invited and contributed talks about scientific motivations, goals, opportunities, and needs in the five fields (exoplanets, space astronomy, space physics, fundamental physics, and outer solar system planetary science). New directions for measurements that are being opened by emergent results and newly understood phenomena will be explored, and science roadmaps to pursue them will be discussed.

A7.3: Technology Needs for Future Missions, Systems, and Instruments

Invited and contributed talks about the technology challenges and plans required to enable breakthrough science objectives in: exoplanet detection and characterization; astronomy throughout the electromagnetic spectrum and using gravitational waves; space physics including fractional gravity regimes and heliophysics; fundamental physics including relativity; and outer solar system planetary science including gas giants, ice giants, complex planetary systems, primordial body populations, and ocean worlds. Topical focus includes measurement techniques, data types, performance requirements, instrument designs, mission concepts and systems, and associated technology developments.

Conference outcome

Symposium A7 was well attended; audiences averaged 50. The Scientific Director of ESA, and representatives of other international space agencies, attended.

32 presentations were planned; two in A7.2 and two in A7.3 were withdrawn. In the weeks prior to the congress, after IAF rearranged the Friday schedule to accommodate Elon Musk, our co-chairs and rapporteurs designed and implemented a plan to negotiate some of our A7.3 authors shifting into A7.2 and A7.1 earlier in the week. To accommodate, we canceled our original plan to end A7.1 with a panel discussion. These changes were entered into the congress programme, with the help of the Secretariat, and they allowed all our committed authors to have full time to present their work.

We formally recommended three papers from each of the three sessions for IAF referral to Acta Astronautica for archival publication.

The symposium has grown stronger in Guadalajara and again in Adelaide. The SATC is actively planning Symposium A7 for the 69th IAC in Bremen.

Scientific Progress in the SATC's Area

Space astronomy and fundamental physics have changed profoundly over even just the past two years. The three most recent decades of space astronomy showed the importance of access to the gamma-ray, X-ray, UV-optical, and near-IR spectrum from space. Combining observations by multiple space observatories and large ground-based facilities advances astrophysics. We can now “see” across the entire electromagnetic spectrum, making high-sensitivity observations from low radio wavelengths to high-energy gamma rays.

Scientifically, the so-called new astronomies (Gravitational Waves, and High-Energy Neutrinos) are expanding our access to astrophysical information. One

of the most important observational challenges of our time is linking discoveries made by the new astronomies with observations of the electromagnetic universe.

This year, such a window opened, through which we should be able to study fundamental events such as binary neutron-star system collapse. The LIGO-VIRGO consortia detected the gravitational wave signal hypothesized for a neutron-star merger, GW170817 [B.P. Abbott et al., Phys. Rev. Lett. 119]. Then just 1.7 seconds later, the INTEGRAL [V. Savchenko et al. 2017 ApJL, 848, L15] and FERMI [A. Goldstein et al. 2017, ApJL, 848, L14] space telescopes detected and located the gamma-ray burst source GRB170817a. Extensive multi-wavelength observations followed [B. P. Abbott et al. 2017, ApJL, 848, L13]. This was humanity's first “multimode” observation of a stellar cataclysm [B. P. Abbott et al. 2017 ApJL, 848, L12].

Also this year, the 2017 Nobel Prize in Physics was awarded to Reiner Weiss and to Barry Barish and Kip Thorne, “for decisive contributions to the LIGO detector and the observation of gravitational waves.”

Looking Forward: 69th IAC, Bremen

We anticipate that the Bremen venue will attract a diverse cross-section of the space astronomy community. The SATC plans two significant contributions to the 69th IAC.

Invited speakers for Symposium A7

At the symposium this year, we aim to explore the scientific objectives accessible to new generations of small instruments and missions, along with existing and developmental technologies that will enable observations on the shortest feasible timescale to achieve great science. Several instrument innovations for SmallSat and CubeSat platforms, supported by agency technology developments and industrial R&D programmes, can be considered for astrophysics. Lower-cost instruments open new possibilities, such as instrument swarms surrounding the Earth. And short turn-around to develop and deploy innovative space instruments will enable scientists to complement large existing space observatories such as INTEGRAL, FERMI and SWIFT.

Plenary/Highlight proposal

We are proposing to IAF a Plenary or Highlight Lecture that would attract and feature key leaders from this year's achievements in gravitational wave and joint observation.

The SATC looks forward to hosting the global community of scientists, technologists, and technical managers from agencies and industry in Bremen, to collaborate on the field of space astronomy.

Space Communications and Navigation Committee (SCAN)

The Space Communications and Navigation Committee examines most recent developments in technology, applications and systems related to fixed and mobile communication services, near-Earth and interplanetary communications, satellite broadcasting, position determination, navigation and timing as well as interactive multimedia provisioning. These topics are dealt with in seven regular sessions and one Global Technical Session where participants can give their papers remotely via the Internet. Eight such presentations were provided in Adelaide. The format of the Interactive Presentations is gaining more and more interest. The electronic screens allowing truly interactivity were well received. Eleven Interactive Presentations from B2 were given. In general, it was positive to see that the attendance in all sessions was very good.

For the Global Networking Forum, SCAN organized a panel and a special presentation.

The panel “Space Optics: Next Steps of Optical Communications Enhancing Our Interconnected World” was moderated by Dr. Norbert Frischauf and Stephanie Wan, both members of SCAN.

As the space communication technologies advance, optical communications are considered to be at the forefront of paving the way of a space data highway. With space qualified lasers becoming available on the market, quantum cryptography is likely to be another major game changer, as it can provide unbreakable security for data transmission using the laws of quantum physics e.g. by entangled photon sources. Industry 4.0, autonomous driving, connectivity in flight and numerous other – not yet invented – applications and services will need fast, reliable and secure global communication and data access means. “Optical fibers in space” will help to unlock mankind’s imagination by boosting communications for an interconnected world. The global interest in optical high-speed space communications has reached such a level that it was considered important to inform the IAF community about this innovative technology and its potential applications and future evolutions.

Top experts in the area of optical communications discussed various aspects of optical communications:

- Matthias Motzigemba, Director Laser Products of TESAT Spacecom, Germany
- Shiro Yamakawa, Japan Aerospace Exploration Agency (JAXA), Japan
- Gerd Rudolf Kraft, Head of the Department of Commercialisation, German Aerospace Centre (DLR), Germany

- Phil Stimson, Assured Communications National Security Group, Australia
- Steve Townes, Chief Technologist of the Interplanetary Network Directorate, NASA, United States

It was clearly stated that free-space optics is a disruptive technology, offering very high interference-free capacity and no charges for the spectrum apply. Big data and data relay are key applications for optical communications. It was interesting to note that the military is increasingly embracing this technology. Optical feeder links are of considerable interest to satellite service providers as this helps to save expensive radio spectrum.

Within the GNF, Otto Koudelka and Ed Ashford gave a presentation on SpaceTech – a master course in Space Systems and Business Engineering.

The space sector is a fast-growing segment. It features most recent research activities and offers the possibility to transfer newly developed technologies in practical use cases. Space industries have, over the years, tended to become multinational in nature. Thus, a demand identified by both industry and agencies was the need to provide training to their prospective future systems engineers and programme managers to prepare them to work in or direct international teams. Industry in particular must have staff that is both highly qualified technically and which understand and can implement the modern business practices that are necessary to run a profitable business in today’s competitive environment. The Graz University of Technology (TU Graz) offers this master’s programme. It is a successor, with an expanded and improved curriculum, to the SpaceTech programme that was offered for thirteen years by the Delft University of Technology in the Netherlands. The programme is hosted by TU Graz under the leadership of the Life Long Learning Department and targets postgraduates with at least 5 years of professional experience. It contains the topics Project Management, Business Engineering, Systems Engineering, Space Mission Analysis and Design, Earth Observation, Navigation, Telecommunications, Interpersonal Skills and Leadership Development, Human Spaceflight, Selected Topics on Space Systems Engineering. Core of the Programme is the Central

Case Project (CCP). The first round of SpaceTech has been successfully completed, the next course will start in March 2018. The CCP was supported by ESA and is related to “Moon Village”. The participants elaborated an innovative concept of cooperating moon rovers.

The SCAN Chair in his capacity as Vice President for



Technical Activities participated in the inauguration of the Select Sub-Committee on Satellite Commercial Applications in Hong Kong in June 2017. It was created for the purpose of promoting satellite commercial applications, their utilization and the benefits for related industries and their customers globally. The Chinese Society of Astronautics, an IAF member, has initiated and has led the origination and organization

of the Select Sub-Committee. The first meeting of this new committee took place during the IAC in Adelaide, chaired by Dengyun Yu, IAF Vice President and Prof. John Horack, Special Advisor to the IAF President. Otto Koudelka and Manfred Wittig, the SCAN Chairs took part in the meeting emphasizing that SCAN will closely cooperate with this new committee.



Inauguration of the Select Subcommittee on Satellite Commercial Applications and Opening of the Committee’s Asian Pacific Office in Hong Kong



Space Education and Outreach Committee (SEOC)

Introduction to SEOC

The SEOC charter is to promote learning and outreach opportunities for students, educators and members of the IAF so that space, science and technology become better known and are more accessible to the global community. This includes activities for students, educators, and the general public through engaging educational (formal and informal) and public information resources and interactions. All manner of satellites, science and spacecraft operations from cubesats to Great Observatories are included to motivate individuals to become interested and involved in science, technology and related disciplines.

Membership

SEOC members are enthusiastic professionals who are directly engaged in and interested in the goals of the SEOC committee. Members not only participate in the annual IAC but also interact with the diverse public through their professional activities supporting education and outreach for space related endeavors. The SEOC organizationally comprises a Chair and several Vice Chairs as well as members who take on specific tasks related to the SEOC goals.



Activities at IAC2017

For IAC2017, the SEOC coordinated E1 symposium on Space education and outreach, including nine technical sessions and one interactive presentation session. All sessions were very successful: the quality of papers and presentations was very high this year and each session was well attended. The new session E1.8 Hands-on space education was a powerful way to demonstrate STEM concepts through hands-on activities. The best interactive presentation in the category Space and Society was attributed to Benjamin Bonsu for his presentation on First Educational Satellite to Enhance Sustainable Space Programme in Ghana, that took place during E1 interactive presentation session.

SEOC is planning to conduct these nine technical sessions again as well as the interactive presentation session for IAC2018.

SEOC is also a partner in the Next Generation Space Leaders Plenary Event with the Workforce Development Young Professionals Programme. The plenary is organized by competitively selecting young professionals and students who are addressing grand challenges through their work and studies. For IAC2017, the topic for the Plenary was "Innovative Methods for Assured and Secure Access to Space Resources" and in particular panellists addressed space debris recognition, cataloging, prevention and removal for safe space operations.

Other Activities

SEOC manages a number of awards and medals including the annual *The Frank J. Malina Astronautics Medal* presented to an educator who has demonstrated excellence in promoting t astronautics and related space sciences for students. This year the recipient was Dr. Lynn Cominsky from Sonoma State University.

Partnerships with other parts of the IAF include chairing the Emerging Space Leaders Grant Programme and the Young Space Leaders Recognition Programme.

SEOC also participates in the IAF Spring Meetings in Paris for abstract selection, as well as conducting business meetings and strategy sessions. As always SEOC presses for the adoption of new technologies for IAF communications and information sharing.



Space Propulsion Committee

The Space Propulsion Committee addresses sub-orbital, Earth to orbit and in-space propulsion. The general areas considered include both chemical and non-chemical rocket propulsion, air-breathing propulsion, and combined air-breathing and rocket systems. Typical specific propulsion categories of interest are liquid, solid and hybrid rocket systems, ramjet, scramjet, and various combinations of air-breathing and rocket propulsion and nuclear, electric, solar and other advanced rocket systems. The Committee is concerned with component technologies, the operation and application to missions of overall propulsion systems and unique propulsion test facilities.

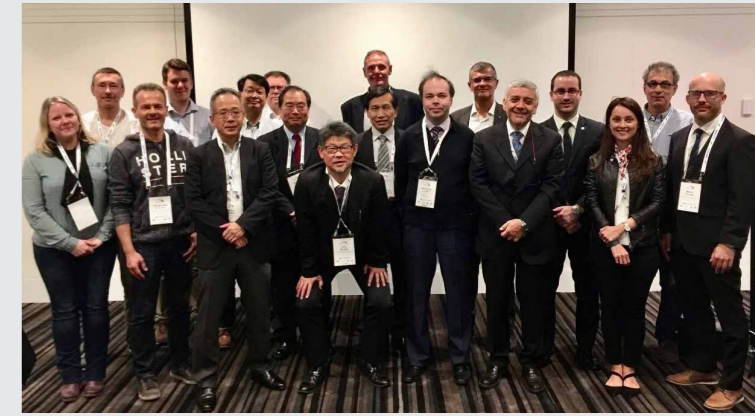
For the term of 2015-2018, the Committee is chaired by Dr. Toru Shimada (JAXA, Japan) and is consisting of 45 members and 1 friend from 36 organizations of industry, government and academia of 16 countries. In 2017 the Committee welcomed 5 new members; Dr.

Changjin Lee (Kokuk University, Republic of Korea), Dr. Sabrina Corpino (Politecnico di Trino, Italy), Mr. Ozan Kara (Space Generation Advisory Council, Turkey), Dr. Mario Kobald (DLR, Germany), and Mr. Martin Velandar (GKN Aerospace Engine Systems, Sweden). There are four co-chairs; Dr. Helen Webber (Reaction Engines Ltd., UK), Mr. Giorgio Saccoccia (ESA, The Netherlands), Mr. Christophe Bonhomme (CNES, France), and Dr. Riheng Zheng (CASIC, China). Whereas Chair is responsible for overall direction of policy and management of the Space Propulsion Symposium, Mr. Saccoccia is for Membership issues and status reports, Mr. Bonhomme is for Coordination of external activities and poster judging, Dr. Webber is for Young professionals and collaboration with other symposia, and Dr. Zheng is for Keynote speakers, new initiatives, networking and publicity.

In IAC2017 Adelaide, the Committee organized Space Propulsion Symposium (C4), to which 293 abstracts were

submitted and 188 abstracts were accepted including 50 interactive presentations. There were 10 oral sessions in C4 and all were quite successful; Propulsion System (1) and (2) (C4.1 and C4.2), Propulsion Technology (1) to (3) (C4.3, C4.5, and C4.10), Electric Propulsion (C4.4), New missions Enabled by New Propulsion Technology and Systems (C4.6), Joint Session on Advanced and Nuclear Power and Propulsion Systems (C4.7-C3.5), Joint Session between IAA and IAF for Small Satellite Propulsion Systems (C4.8-B4.5A), Hypersonic Air-breathing and Combined Cycle Propulsion (C4.9).

Five keynote lectures were conducted in 5 sessions and they overall were very popular since the audiences were able to listen to the information collected for each specialized field. As an outreach effort of the Committee, a brochure of Space Propulsion Symposium is now in final editing process. It will come up for example in Facebook or other social network links of IAF.



The photo was taken at the TC meeting held on 24 September 2017 at Riverbank Room 8a, Adelaide Convention Centre. From the left: V. Vial, S. Henry, C. Bonhomme, M. Kobald, A. Ogawara, C. Lee, N. Puetmann, S. Aso, T. Shimada, G. Schmidt, Y. Chen, A. Lovtsov, G. Saccoccia, S. Borrelli, A. Lorente, S. Corpino, P. Danous, M. Velandar.

Space Transportation Committee

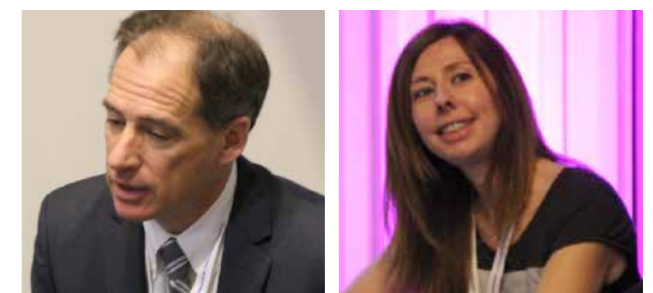
Space Transportation Committee Activities during 2017 IAF Spring Meetings

To prepare for the coming congress in Adelaide, we Space Transportation Committee held our meeting on 22nd March in Paris. Because our Vice-Chair, Ms. Emmanuelle left DLR and join RUAG group, she can seldom attend spring meeting or IAC. Therefore she resigned from the committee. We elected Markus Jaeger as our new Vice-Chair.



Space Transportation Committee Meeting in Paris, 2017

This year four candidates came to the Space Transportation meeting and introduced themselves. Mr. Shen Lin from China Academy of Launch Vehicle Technology, Mr. Brian Smith and Mr. Jerry Cook from NASA, and Ms. Aline Decadi from ESA, finally become our new members after election.



Our new Members

After attending IPC General Meeting, we, Space Transportation Committee, accomplished our paper selection tasks. This year we use the online system rather than printed sheet, which is much more efficient and convenient for operation. There are also more papers transferred between sessions.



Paper selection after IPC General Meeting

Space Transportation Committee activities during IAC2017

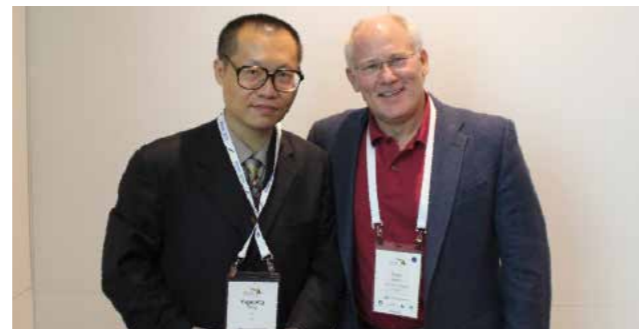
According to our tradition, we Space Transportation Committee held our meeting on Sunday 24 September, just before the opening ceremony of IAC2017. This is a very important preparation of the 9 technical sessions we are in charge of. Our chair, Mr. Steve Creech from NASA, vice-chair, Mr. Markus Jaeger from Airbus, and secretary, Mr. Yang Yuguang from CASIC hosted the meeting.



Space Transportation Committee Meeting before IAC2017

Transportation is the essential foundation of space activities, the space transportation solutions and innovation symposium covers topics about launches vehicles, upper stages, EDL, space transportation systems and deep space missions. It is one of the most important symposium in IAC.

During our Committee Meeting, we carefully prepared every session and confirmed the Co-Chairs and rapporteurs of each session. Because Elon Musk will give a lecture on the last day of IAC. The arrangement of D2.8 and D2.9 session would have a different schedule comparing with other sessions. We carefully arranged everything and finally every session is successful. Because this year there are more than 4,000 delegates. There are also more audience during each D2 session. Usually there are more than 50 persons listening to the presentations.



Our Member, Dr. Andrew J. Aldrin from FIT

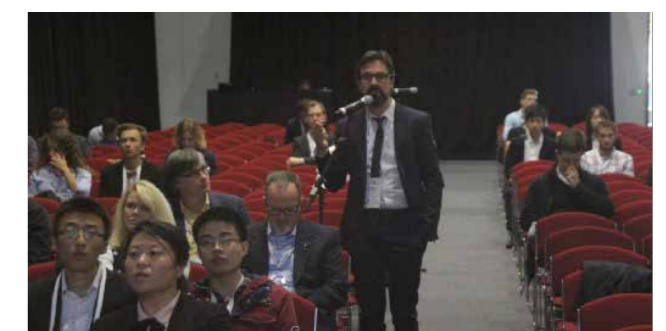
During the meeting we also elected Dr. Andrew J. Aldrin from FIT as our new member, and appointed him as one of the Co-Chairs of D2.8 session.

The highlight of Space Transportation Meeting this year is that we organized a special D2 Seminar before the end of our meeting. Members from different countries introduced the space transportation technologies, products and missions of their companies or their countries. We also discussed and exchanged our views about the future development of space transportation solutions. We all agree that the committee should enhance this kind of discussion in the future.



A "D2 Seminar" on Space Transportation Technology

On Friday morning, D2.8-A5.4 joint session was held in the congress. Dr. Andrew J. Aldrin, Dr. Yang Yuguang and Dr. Gerhard Schwem chaired the session. Although this is the last day of the congress, still we have more than 50 audience. 8 high quality papers were presented during the session. Finally, the top 3 were delivered to Acta Astronautica.



A "D2 Seminar" on Space Transportation Technology





Space Transportation Dinner during IAC2017

In every IAC, we, Space Transportation Committee, have dinner on the fourth day of the Congress. This year, we choose "The Little Hunter of Adelaide". Members all over the world came together, tasted the delicious Australian food and enjoyed the happy night!



Space Transportation Dinner

Space Transportation Members on China Central Television

In 2017, China performed its first Cargo ship mission, Tianzhou-1 flying to its Tiangong-2 Space Laboratory. Prof. Dr. Yang Yuguang, Secretary of Space Transportation Committee was invited to China Central Television's CGTN channel as expert to explain technical details. Being invited by Yang, our former chair, Prof. John Horack also joined the discussion.



Dr Yang Yuguang and Prof. John Horack on China Central Television

In June 2017, IAF held GLEX in Beijing. Prof. Dr. Yang Yuguang, secretary of Space Transportation Committee invited Dr. Christian Feichtinger, Executive Director of IAF, and Prof. Roberto Battiston, President of Italian Space Agency to join the programmes on Central Television, discussing about GLEX2017 and international space cooperation.



Dr Yuguang Yang, Secretary of the Space Transportation Committee during GLEX



IAF on China Central Television



IAF Committees' Reports

ADMINISTRATIVE COMMITTEES

Honours and Awards Committee (HAC)

The principle functions of the Honours and Awards Committee are to:

- review the structure, terms and conditions of all the honours and awards offered by the IAF to ensure relevance, consistency and standards;
- recommend or address, as appropriate, new awards or revisions of current awards to or from the Bureau;
- have oversight, on behalf of the Bureau, of all awards made by IAF subcommittees to ensure standards;
- select from nominations for awards having no dedicated sub-committee and recommend recipients to the Bureau (e.g. the Allan D. Emil Memorial Award).

The committee members are:

- Pierre Bescond (Acting Chair)
- Maria Antonietta Perino (Chair DSA sub-Committee)
- Chris Welch (IAF VP for Education and Workforce Development)
- Clayton Mowry (IAF VP for Financial Matters and IAC Evolution)
- Karl Doetsch
- Li Ming

- Lyn Wigbels
- Marina Sologub
- Christophe Bonnal
- Kuniaki Shiraki
- Garry Popov
- Elizabeth Seward

Membership Status

Former HAC Chair, Sir Martin Sweeting resigned in 2017 and Dr. Pierre Bescond, IAF Hall of Fame Subcommittee Chair is now Acting Chair of the committee. The committee is composed of twelve members from nine different countries. The IAF is grateful to **Sir Martin Sweeting** for the intense activity he has deployed all along these years for the benefit of the HAC and the IAF.

HAC meeting at IAC 2017 in Adelaide

The President and the Executive Director of the IAF, Jean-Yves Le Gall and Christian Feichtinger, took part in the discussions of the committee. The President reaffirmed the importance of the HAC and the great visibility it brings to the Federation.



Honours and Awards Committee Meeting at IAC 2017 in Adelaide, Australia



Sessions and activities at IAC 2017

HAC is responsible for the honours and awards conferred by the Federation. During the IAC2017, the following awards under the committee's responsibility were given:

- The IAF most prestigious award, **The IAF World Space Award** was presented to **Maj. Gen. Charles F. Bolden** during the Opening Ceremony held on Monday 25 September 2017. On this occasion, Mr. Bolden gave a special lecture on Wednesday 27, on the topic '**Growing Opportunities for International Cooperation in Science and Astronautics**'. The lecture was moderated by former IAF Vice-President for Honours and Awards, **Dr. V. Koteswara Rao**.
- The **Allan D. Emil Memorial Award** was conferred to **Dr. Lei Fanpei**, Chairman of China Aerospace Science and Technology Corporation (CASC) and President of Executive Council of Chinese Society of Astronautics (CSA), on Friday 29 September 2017 during the Closing Ceremony.
- On the same day, the **Frank J. Malina Astronautics Medal** was awarded to **Prof. Lynn Cominsky**, Chair of the Physics and Astronomy Department at Sonoma State University (SSU).

During the IAC2017, a new IAF Vice-President for Honours and Awards was elected: **Dr. Seishiro Kibe**, Senior Advisor at the Japan Aerospace Exploration Agency (JAXA). The IAF would like to warmly thank **Dr. V. Koteswara Rao**, departing IAF Vice-President for Honours and Awards for his outstanding contribution to the HAC and IAF.

The **IAF Hall of Fame** is awarded for outstanding contributions to the advancement of astronautics in a specific field (science, technology, management, applications...) within the framework of the IAF activities or lifetime achievements. In 2017, Richard Kline, Berndt Feuerbacher, Stanislav Konyukhov, and Robert Briskman had the honour to receive this distinguished award.

Finally, **Mino Rathnasabapathy**, **Patrick Hambloch**, **Stephanie Wan**, **Timiebi Aganaba-Jeanty**, and **Laszlo Bacsardi** were awarded as IAF Young Space Leaders and the 14 **IAF Emerging Space Leaders** received a certificate. As of 2018, the number of IAF ESL Grant recipients will be of 25.



Maj. Gen. Charles Bolden, 2017 IAF World Space Award recipient



Prof. Lynn Cominsky, 2017 Frank J. Malina Astronautics Medal recipient



International Project/Programme Management Committee (IPMC)

It is my great pleasure as Chairman of the International Project/Programme Management Committee (IPMC) [ed: Roger Forsgren] to provide highlights of our activities focused on an exchange of information, mutually beneficial activities and sharing best practices for enhancing the management of space programmes and projects through training and curriculum development, knowledge sharing, lessons learned, and related research activities.

IPMC elections were held at the IAC 2017 and unanimously elected Mr. Roger Forsgren (NASA) as IPMC Chair. Mr. Lionel Baize continues to serve in the capacity as IPMC Vice-Chair (CNES) and Mr. Robert Clairmont Jr. (NASA) serves as IPMC Secretariat replacing Mr. James Zimmerman. The IPMC member list (~35 members) is being updated and will be published prior to the 2018 IAF Spring Meeting in Paris.

IPMC Standing Space Agency Subcommittee (SSAS)
– Mr. Takashi Ohtani (JAXA), Chair and Mr. Ruediger

Suess (DLR), Vice-Chair introduced a new Project Management and Systems Engineering Survey to IPMC members to promote common space agency interests regarding governance structures (programme/project), relationships with line organizations, and decision making processes.

Sessions and Activities at IAC 2017 (Adelaide, Australia) – 2017 IPMC Young Professionals Workshop was held on 24 September 2017 at the Adelaide Convention Centre with 29 workshop delegates from 13 organizations (4 continents and 12 countries represented) including PRO, NGO, industry/commercial, and academia. Workshop delegates reported on the following three topics:

- **Topic 1: On The Side Projects**
- **Topic 2: Learning Partnerships**
- **Topic 3: Space 4.0**



2018 IPMC Young Professionals Workshop (Bremen, Germany) Schedule:

- January – June 2018: Call for Delegates
- July – August 2018: Literature Review and Research
- September 2018: Draft Report/Presentation and Workshop
- October 2018: Final Report to IPMC

International Project Management (IPM) Course managed by NASA in collaboration with IPMC – This course provides project practitioners with an understanding of cultural challenges, legal concerns, and teaming issues that are likely to be encountered when working with international partners. Two distinct facets of successful international project management are addressed: technical knowledge and cultural understanding. Participants gain insights into the

characteristics of international teaming that have the potential to make or break a project through the use of lectures, small group discussion, hands-on practical exercises, and case studies.

- **IPM #17 (27 February – 3 March, 2017)** – This course was attended by 10 International organizations (CNES, CSA, DLR, ESA, JAXA, KARI, OHB, SANSa, and TAS) with 17 international participants. Pictured below is the IPM #17 class.
- **IPM #18 (10-15 September 2017)** – Course cancelled due to Hurricane Irma's impact to the State of Florida and the Kennedy Space Center.

2018 IPM Courses Dates:

- IPM #19 – 25 February – 2 March 2018
- IPM #20 – 15-20 July, 2018



IPM #17 class.

Space Universities Administrative Committee (SUAC)

Introduction to the Committee

The purpose of the Space Universities Administrative Committee (SUAC) is to encourage the international collaboration among academic structures involved in space activities, including technical and non-technical universities. The Committee is building an international network of Space Universities. (<http://www.iafastro.org/committees/space-universities-administrative-committee-suac/>)

Membership Status

The 40 members of SUAC are Universities, members of IAF, willing to collaborate in promoting Sciences and Technologies among the students through space activities:

- Create recurrent flight opportunities for small / nano satellite missions
- Encourage the new generation to participate in hands-on international collaborative missions
- Stimulate the knowledge sharing between experienced nanosatellite teams and newcomers
- Benefit from multiple flight profiles, experiencing different orbits, and different mission conditions.
- Organize a student Workshop just after IAC conference

The organization of SUAC is based on one Chair (Prof. Pierre Rochus) and Regional Vice-Chairs. Several working groups are created to deal in a more effective manner with the different projects undertaken by SUAC.

Sessions and Activities at IAC 2017

SUAC meets at least twice a year at the IAF Spring Meetings and at the IAC. This year, SUAC supported a proposal "SaTec" for elite educational programme by Professor Klaus Schilling and the China Postgraduate Future Flight Vehicle Innovation Competition (FFVC), which took place from 18 to 20 August, 2017, in Nanjing, China. SUAC will organize a Student Workshop at the next IAC in Bremen.



IAF 2017 Activities

OTHER EVENTS



China Postgraduate Future Flight Vehicle Innovation Competition

New Activities

Professor Pierre Rochus, SUAC Chairman, discussed with Dr. Zhang Wei, the Chairman of the Board of Trustees of Northwestern Polytechnical University, on 25th Sep for the possible cooperation between SUAC and the Charter of The “Belt and Road” Aerospace Innovation Alliance. (BRAIA is an international aerospace organization composed of universities, research institutes, and academic organizations. BRAIA is initiated by Northwestern Polytechnical University and Chinese Society of Astronautics. The alliance is established in April 2017.) The proposal was accepted by the Committee and SUAC will now cooperate with the “Belt and Road” Aerospace Innovation Alliance (BRAIA) to hold several very important space events in China.

- (1) SUAC and BRAIA will hold the Chinese CubeSat Mission Contest The BRAIA will also hold a China Microsatellite Symposium with SUAC and Chinese Society of Astronautics. This symposium is supported by the China National Space Administration. During this symposium, one of the most important sessions is the discussing of the CubeSat education constellation. The teams that join the project could get free launch opportunity. The team could also get free training and free CubeSat subsystems for the developing countries.



Meeting between SUAC Chairman and Dr. Zhang Wei (NPU)



Global Space Congress 2017

On the 31 January and 1 February the IAF was present in Abu Dhabi to participate in the Global Space Congress 2017.

On the opening day of the event, IAF President, Dr. Le Gall, gave a speech on the importance of international cooperation and H.E. Dr. Mohammed Al Ahbabi, Director General of the UAE Space Agency, officially announced the intention of Dubai to bid for hosting IAC2020.



In the afternoon, the IAF hosted a “3G” IDEA Diversity Luncheon, with prominent keynote speakers such as Prof. Pascale Ehrenfreund, Chair of the Executive Board of DLR and IAF Vice President, and Dr. Sarah Amiri, Deputy Project Manager and Science Lead, Emirates Mars Mission from the Mohammed bin Rashid Space Centre.



33rd International Space Symposium and Space Tech Expo

The IAF was again present at the 33rd International Space Symposium on 3 – 6 April 2017 in Colorado Springs and – for the first time - at the Space Tech Expo on 23 – 25 May 2017 in Pasadena, CA United States, to promote IAF membership and IAC2017.



UN COPUOS and Paris Air Show

The IAF was also present in June at the 60th session of the UN Committee on the Peaceful Uses of Outer Space (UNCOPUOS) which took place from 7 – 16 June 2017 in Vienna, and gave a statement.

The Federation also attended the Paris Air Show Le Bourget 2017, held from 19 – 25 June 2017 to promote IAF membership as well as the IAC2017.

MAKS Air Show in Moscow

The IAF was also present at this year's Moscow Airshow MAKS 2017 from 18 – 23 July 2017 making contact with IAF members and promoting IAF membership. An IAF promotional event was held in cooperation with

ROSCOSMOS with the participation of the IAF President, Jean-Yves Le Gall and the IAF Vice Presidents Pascale Ehrenfreund, Jan Woerner and Sergey Krikalev.



MAKS Air Show in Moscow



United Nations/Austria Symposium “Access to Space: Holistic Capacity Building for the 21st Century”

The IAF has participated in the United Nations / Austria Symposium in Graz beginning of September 2017. IAF Vice Presidents Otto Koudelka (Co-Organizer of the Symposium) and Pascale Ehrenfreund were present and Christian Feichtinger, IAF Executive Director gave a presentation on “Capacity Building in the Context of the International Astronautical Federation”.



NEW IAF COMMUNICATIONS INITIATIVES

This Day in Space



The IAF believes that history plays a vital role in our everyday lives. The study of past events shape our future actions, preparing us for the future. Humanity tends to go through the same challenges over and over again. The only difference is that people learn from what has already happened and develop better problem-solving mechanisms.

Therefore, the IAF decided to celebrate the history of space with a new series of videos honouring important milestones in the building of the relationship between humans and outer space named: This Day in Space.

IAC TV

As an additional service to IAC Delegates, the International Astronautical Federation (IAF) has partnered with the international film and broadcasting company, WebsEdge, to create the IAC TV. This is an on-site IAC television channel featuring a new episode daily, filmed and screened around the Convention Centre. The TV segments profiled prominent space educators and scientists, highlighted the hard work of societies, companies, associations, agencies, museums, universities, institutes and organizations committed to elevating the quality of space in the world, and offered the chance to learn about new strategies and techniques. IAC TV has provided unique opportunities for IAC delegates to give onsite interviews on topics of their concerns and their impressions from the congress. You may watch all videos on the IAF YouTube Channel.

By memorializing these crucial moments, the IAF is contributing in equipping the IAF Community with vital skills to understand what informed the actions of those before us as well as helping us in finding new inspiration by remembering how others overcame adversities and innovate; it also creates a sense of moral understanding thus enhancing our belonging and loyalty to all space aspects; it builds a cultural consciousness and cross-cultural appreciation that makes us better citizens into a better society. Most importantly, the celebration of history is fun!



THE INTERNATIONAL ASTRONAUTICAL FEDERATION

Connecting @ll Space People

WHO WE ARE

Founded in 1951, the International Astronautical Federation (IAF) is the world's leading space advocacy body with over 340 members from 68 countries on six continents including all leading agencies, space companies, societies, associations, universities and institutes worldwide.

Following its theme "A space-faring world cooperating for the benefit of humanity", the Federation advances knowledge about space, fostering the development and application of space assets by advancing global cooperation. As organizer of the annual International Astronautical Congress (IAC) as well as other thematic conferences and workshops, the IAF actively encourages the development of astronautics for peaceful purposes and supports the dissemination of scientific and technical information related to space.

WHAT WE DO

Promoting cooperation

The IAF's International Astronautical Congress and various IAF committees provide unique collaborative platforms for experts from space agencies, industry and research

Advancing international development

The IAF is building a future of cooperation, development and international friendship, bringing together experts from experienced and emerging space nations alike

Sharing knowledge

The Federation has many well-established channels to disseminate information within its global network and the wider space community

Recognising achievements

The Federation's prestigious awards are presented annually to individuals and groups who have distinguished themselves in the global space community

Preparing the workforce of tomorrow

To nurture new talent, the Federation has many activities targeting students and young professionals

Raising awareness

The global network of the IAF, and IAF publications, help promote the public appreciation of space activities worldwide

BECOME A MEMBER

Membership in the IAF is open to all companies and organizations working in space-related fields.

If you are interested in becoming a member, please complete the "Application for IAF Membership" form (which can be found on our website: <http://www.iafastro.org/membership>) and send it together with your company's by-law, statutes and any other relevant material to the IAF Secretariat.

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IAF Alliance Programme Partners:



IAF EVENTS 2018



Spring Meetings
2018
27-29 March 2018
Paris, France



BREMEN 2018
1-5 October 2018
Bremen, Germany



2017
INTERNATIONAL
SPACE FORUM
AT MINISTERIAL LEVEL
THE AFRICAN CHAPTER
13 February 2018
Nairobi, Kenya

(Postponed from November 2017)



2018
Global Space
Applications Conference
21-23 May 2018
Montevideo, Uruguay

Be part of the conversation on [@iafastro](#)



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