



**INTERNATIONAL  
ASTRONAUTICAL  
FEDERATION**

# IAF HIGHLIGHTS

# 2016



*Connecting @ll Space People*



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# WELCOME

message  
from the IAF President



I am delighted to present you with this publication, IAF Highlights 2016, where you will find a compilation of IAF's most memorable activities during the year. In 2016, the IAF organized several very successful events: SM in Paris, GLIS in Geneva, IAC in Guadalajara and ISF in Trento. These events were attended by high-level speakers and they hosted fruitful discussions on a number of topics. A strong focus was on accessibility, connectivity and the role of space in taking on global challenges.

Our Global Conference on Space and the Information Society, GLIS 2016, was organized with the International Telecommunication Union (ITU) on the theme "Connecting the world via space – policies, technologies, applications". Over two days in June, experts came together in Switzerland to examine the different means by which space is helping people to connect worldwide and its impact on their lives and organizations.

The International Astronautical Congress, IAC 2016, in Guadalajara, Mexico, was a great success with a record number of over 5,200 attendees. This year the congress was organized with the Mexican Space Agency (AEM) on the theme "Making Space Accessible and Affordable to All Countries". It was an inspiring week full of activities, where

representatives from developing and advanced space nations alike got together to discuss core issues and future collaborations.

In October, a new conference, the first International Space Forum at Ministerial Level (ISF), was organized with ASI, the Italian Space Agency. The ISF 2016 gathered ministers, ambassadors, heads of space agencies, representatives of international intergovernmental organizations and universities from 35 countries in the north of Italy to discuss "Space Science and Academy for Global Challenges".

As important as it is to look back on all the achievements of the year, we are now very focused on 2017, which we hope will turn out to be an excellent and outstanding one both for IAF and for the whole of our community.

*Jean-Yves Le Gall*



# WELCOME

message from the IAF VP  
for Communications, Publications  
and Global Conferences

As the new Vice-President for Publications, Communications and Global Conferences, I have the pleasure to introduce you to our most recent publication, the IAF Highlights. This initiative is built on the previous annual journal "Highlights in Space" that the IAF used to co-publish together with UNOOSA. Last year the discussion came up again to create a new annual journal, since a publication that truly reflects the IAF and covers what has happened in the events during the year, was missing.

For newcomers not already familiar with the International Astronautical Federation it can be difficult to understand what the IAF really is and what kind of events we organize. Therefore this journal is also meant as a tool to get a deeper understanding on how to take part in the IAF community. The publication does give visibility to all of our Committees, both technical and administrative, who get the opportunity to show their activities and what they have discussed throughout the year.

Eventually the new IAF Highlights journal emerged, and you are now reading the first edition of it! In here you will find reports on the main events, committee reports and additional highlights from 2016.

I hope that you will sincerely enjoy this publication and we look forward to create many more highlights together with you in 2017!

*Pascale Ehrenfreund*



# IAF General Assembly



The International Astronautical Federation General Assembly has gathered during the International Astronautical Congress, IAC 2016, in two sessions (Monday 26 September 2016, and Friday 30 September 2016). Several important decisions have been taken.

## 2016 Elections of IAF Officers

Dr. Jean-Yves Le Gall's assumption of duties as IAF President has officially taken place during the IAF General Assembly, on Friday 30 September 2016. Dr. Le Gall had been elected incoming President at IAC 2015 in Jerusalem and has assumed full presidency at IAC 2016 for a term of 3 years and presented his IAF Global Innovation Agenda 2016-2019 (please see page 6 for full details).

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

- **Pascale Ehrenfreund** – Chair of Executive Board, German Aerospace Center (DLR), Austria, has been appointed as IAF VP for COMMUNICATIONS, PUBLICATIONS AND GLOBAL CONFERENCES
- **Sergey Krikalev** – Executive Director for Piloted Spaceflights, ROSCOSMOS, Russia, has been appointed as IAF VP for INTERNATIONAL RELATIONS AND OUTREACH
- **Clayton Mowry** – Lead – Sales, Marketing & Customer Experience, Blue Origin, USA, has been appointed as IAF VP for FINANCIAL MATTERS AND IAC EVOLUTION
- **Johann-Dietrich Woerner** – Director General, European Space Agency (ESA), Germany, has been appointed as IAF VP for AGENCY, PARLIAMENTARIAN AND MINISTERIAL RELATIONS

## Selection of Host City for IAC 2019

The IAF General Assembly at its second session on September 30, selected **Washington DC** as **Host City for IAC 2019**. The Hosting Organization is the American Institute of Aeronautics and Astronautics (AIAA), a member of IAF since 1952.

## Upcoming IAF Events Reports

During the IAF General Assembly sessions, reports were given on the advancement of preparation for the IAC 2017 in Adelaide, Australia and for the IAC 2018 in Bremen, Germany.

Also, a detailed presentation was offered on the progress made in the organisation of the Global Conference on Space Exploration, GLEX2017, that will take place in Beijing, China, from 6-8 June 2017 in cooperation with the Chinese Society of Astronautics (CSA).

The IAF General Assembly has also endorsed the organisation of a Global Space Applications Conference in 2018 (GLAC 2018). The International Astronautical Federation (IAF) and the Centro de Investigación y Difusión Aeronáutica Espacial (CIDA-E) will be co-organising the event in Punta del Este, Uruguay in June 2018.

## IAF Finance

The IAF has also approved the **final accounts 2015 and Auditor's Statement 2015** and the **revised budget and preliminary accounts 2016** and the **Proposed Budget 2017**.

## New IAF Members

The IAF General Assembly also approved the applications of 25 new Member Organizations from 15 countries worldwide. With this, the IAF Membership comprises 327 Member Organizations from 66 countries, confirming IAF's position as a truly global Federation.

Company	Category	Region	Country
Aexa Aerospace LLC	Industry	North America	United States
Astrosat Limited (UK)	Industry	Europe	United Kingdom
Auspace Pty Ltd.	Industry	Oceania	Australia
Blue Origin	Industry	North America	United States
Cyprus Space Exploration Organisation (CSEO)	Association & Professional Society	Europe	Cyprus
Danish Aerospace Company ApS	Industry	Europe	Denmark
Embry-Riddle Aeronautical University	University	North America	United States
Friedrich-Schiller-Universität Jena	University	Europe	Germany
Korea Aerospace Industries	Industry	Asia	Korea
Korea Association for Space Technology Promotion (KASP)	Association & Professional Society	Asia	Korea
MXSpace A.C	Association & Professional Society	South America	Mexico
National Institute of Information and Communications Technology (NICT)	R&D	Asia	Japan
Orbital Access Ltd	Industry	Europe	UK
Peoples' Friendship University of Russia	University	Europe	Russian Federation
Politecnico di Milano	University	Europe	Italy
RHEATECH LTD	Industry	Europe	UK
Rovsing A/S	Industry	Europe	Denmark
Soletop Co., Ltd	Industry	Asia	Korea
SpaceX	Industry	North America	United States
Space Trust	Association & Professional Society	Europe	United Kingdom
The Tauri Group	Industry	North America	United States
UAE Space Agency	Space Agency	Asia	United Arab Emirates
Universiti Teknologi Mara (UITM)	University	Asia	Malaysia
University of Adelaide	University	Oceania	Adelaide
Wildcard Mavericks Ltd	Industry	Europe	UK

# IAF Global Innovation Agenda

## 2016-2019

After being elected as IAF President in September 2016, Jean-Yves Le Gall has officially introduced to the IAF community his strategic plan for his 3-years presidency. Following the example of his predecessor, Kiyoshi Higuchi, and thanks to the cooperation and counsel of many actors within the Federation, including the Secretariat, he has created the new IAF Agenda for 2016-2019.

The **“IAF Global Innovation Agenda 2016-2019”** is based on the following principles:

- Preserving our heritage and building on existing strengths,
- Listening and Opening up to the World,
- Preparing the future and **Connecting @II Space People.**

In implementing this Agenda the IAF shall focus on the following 7 concrete priority actions, which will allow the Federation to remain the leading global space association and to further increase its reach, influence and impact on the successful and peaceful development of space for the benefit of humanity.

### 1. Reach out to Emerging Countries and Connect with New Communities

The IAF has to contribute to bridging the gap between established and emerging space nations and actors, embrace new communities and offer its global network for encouraging cooperation and promoting international development.

A dedicated IAF Working Group on “Emerging Countries and New Communities” has been established and tasked to investigate how to:

- Stronger involve emerging countries in the IAF activities;
- Attract new communities like internet companies;
- Produce benefits for these communities and countries.

IAF VP for Developing Countries and Emerging Members, **Joo-Jin Lee**; IAF VP for Global Membership Development and Diversity Initiatives, **Mary Snitch** and IAF VP for Science and Academic Relations, **Roberto Battiston**, are currently co-chairing this Working Group.

### 2. Foster the Principles of “3-G” Diversity within the Federation and the Space Sector

**Geography, Generation and Gender** are the main pillars of a “3-G” Diversity principle of the Federation and it is the declared aim of the Federation to become an exemplary organisation in terms of geographical, generational, gender and any other diversity aspects, and live up to its motto **Connecting @II Space People.**



**INTERNATIONAL PLATFORM FOR DIVERSITY AND EQUALITY IN ASTRONAUTICS**  
3G GEOGRAPHY • GENERATION • GENDER



Concrete actions to accomplish this include:

- Encouraging and supporting space communities in remote areas to engage in the Federation’s activities;
- Further increasing the involvement of and the offer to the young generation within the Federation and its activities;
- Reviving the IAF mentoring programme;
- Attracting specifically the female space community to become active and take over leadership within IAF bodies;
- Establishing IAF focus on all diversity aspects and promoting diversity as a basic principle to the entire global space community.

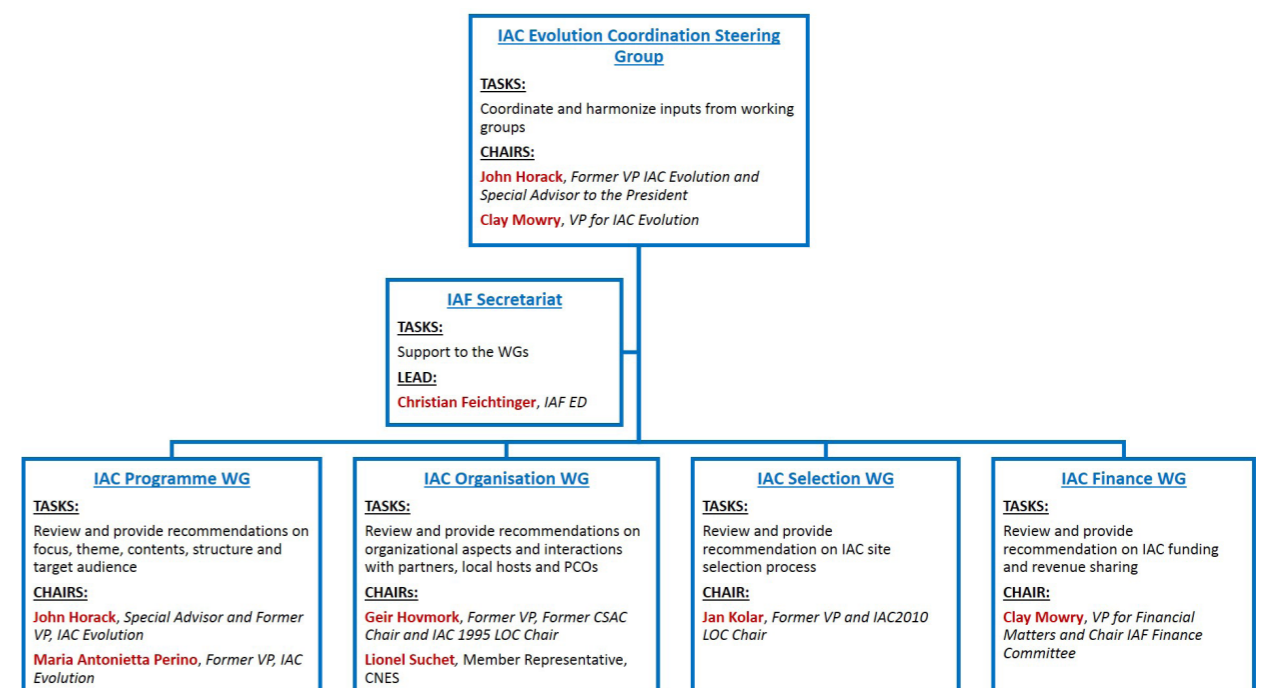
All activities related to diversity are driven by the IAF Secretariat in close cooperation with the IAF VP for Diversity Initiatives, **Mary Snitch**. To achieve this goal, the Federation has already created an **IAF International Platform for Diversity and Equality in Astronautics (“IDEA”)**, which was inaugurated with a lunch at the IAC2016 and an **IAF Excellence in “3G” Diversity Award**.

### 3. Evolution of the International Astronautical Congress with a View on Sustainability and Future Growth

It is time now to review the manifold aspects of organizing the International Astronautical Congress in its present form and investigate on the evolution of the IAC in the years to come with a strong view on its sustainability and future growth. In this respect the IAF has already created 4 Working Groups to investigate key aspects of the IAC of the future, such as:

- Focus, theme, contents, structure and target audience – IAC Programme WG
- Organization and interaction with partners, local hosts and PCOs – IAC Organisation WG
- Site selection process – IAC Selection WG
- Funding and revenue sharing – IAC Finance WG

These four WGs, their investigations and inputs will be coordinated and integrated, for a most efficient mode of operation, by an IAC Evolution Coordination Steering Group (please see image below for WGs structure and Chairs).





#### 4. Global and Regional Conferences

In order to maintain the attractiveness of these IAF conferences and provide enhanced opportunities for IAF members, including the organization of “Regional Conferences”, the following aspects will be investigated and further developed under the responsibility of the IAF VP for Global Conferences, **Pascale Ehrenfreund** in:

- Review of purpose and rationale;
- Selection process;
- Mid- and long-term planning.

Plans are already in place for the organisation of **GLEX 2017** in Beijing, China (6-8 June 2017) in cooperation with CSA and **GLAC 2018** in Punta del Este, Uruguay in cooperation with CIDA-E. In addition, the IAF Secretariat will review proposals for 2019 and 2020 and prepare recommendation to Bureau.

#### 5. Relations and Interaction with IAF Partner Organizations

The IAF has been cooperating with its traditional partners, the International Academy of Astronautics (IAA) and the International Institute of Space Law (IISL) within the definition and implementation of the IAC Technical Programme. It has also successfully cooperated with international organizations, such as the United Nations Office for Outer Space Affairs (UNOOSA), COSPAR, UNESCO, ITU, and others.

The IAF Secretariat in close cooperation with President Le Gall will work on the identification of synergies and common goals and establish formal agreements regulating the partners’ interaction and cooperation, where appropriate.

#### 6. Evolution of IAF Funding Structure

The IAF Secretariat in close cooperation with the IAF Finance Committee and the IAF VP for Finance Matters, **Clay Mowry**, will investigate ways of

making the IAF funding structure less dependable on the financial result of the IACs. Such effort will take due consideration of a further development of the IAF Alliance Programme, sponsorship activities, IAF publications and the financial results of Global and Regional Conferences.

#### 7. Lead the IAF towards the Future with Innovative Projects

In continuation of its effort to permanently develop new activities and provide additional offers and services to our members the IAF will establish and implement innovative projects, such as:

- **A Digital Paper Archive System;**
  - Phase 1 (digitalization of papers) completed
  - Phase 2 (user interface system) in development, planned completion by March 2017
- **A platform for members to meet and exchange outside the frame of an IAC “IAF Connect”;**
  - To be developed by IAF Secretariat in cooperation with VPs for Global Membership Development and Industry Relations
  - First concept presentation by March 2017
- **An IAF Ambassadorship programme;**
  - Review previous IAF Ambassadorship programmes dedicated to IACs
  - Secretariat to propose potential new Ambassadorship programme
- **Enhanced communication tools, like an IAF App;**
  - **IAF App** – in development, completion of Phase 1 (without events part) expected by March 2017
  - **IAF Journal** – which you are currently reading!

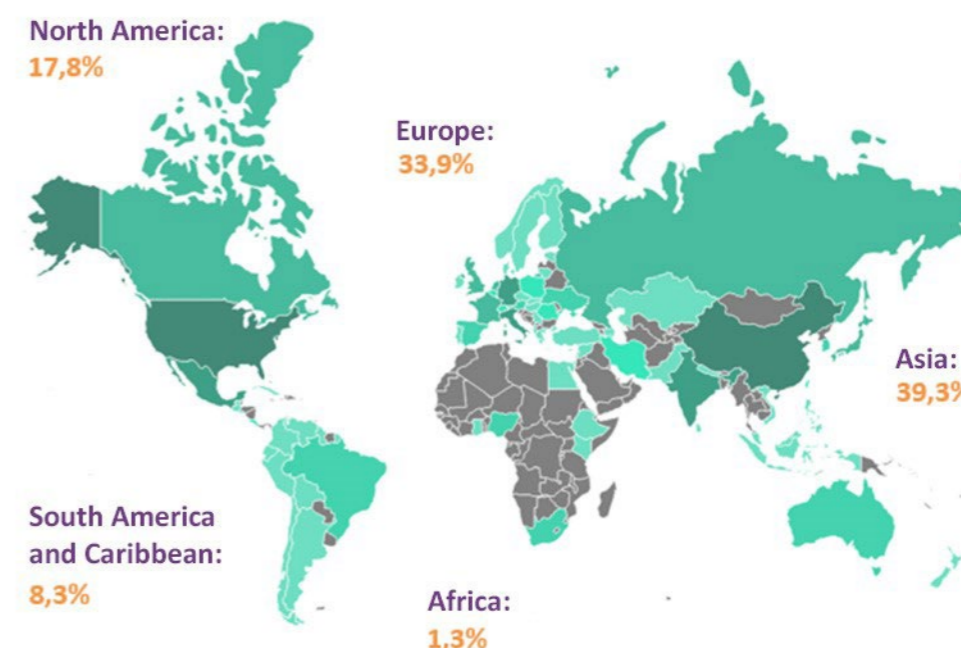
Thanks to this *IAF Global Innovation Agenda 2016-2019*, with hard work and the support of the IAF Bureau, Members and volunteers, the Federation can accomplish great things and make a real difference in the future of the space sector.



## Spring Meetings 2016

During 22-24 March 400 attendees gathered for our annual Spring Meetings in Paris. Three intensive days were filled with meetings, GNF sessions and the IAC 2016 abstract selection. In total we received 2775 abstracts for IAC 2016 from 78 different countries, of these 2199 were accepted, 449 abstracts for Interactive Presentation and 1750 for

Oral Presentations. Two GNF sessions were held. The first sessions was “**COP21 Results and their Impact on Space Activities**” moderated by Josef Aschbacher. The second session was the “**Moon village concept presentation**” by Jan Woerner, Director General of ESA.



Geographical distribution of IAC2016 submitted abstracts

# IAF Global Conferences



## GLIS 2016



The **Global Conference on Space and the Information Society** was held in Geneva, Switzerland from 6 – 7 June. The theme for this conference was:

*“Connecting the world via space – policies, technologies, applications”*

The conference was co-organized by the International Astronautical Federation (IAF) and the International Telecommunication Union (ITU). The main purpose of GLIS 2016 was to examine and

discuss the different means by which space allows people to connect worldwide and the impact that space policies, space technologies and space applications have on the daily life of people, organisations and governments around the world.

### The conference consisted of five plenaries:

- Plenary 1:** The ITU and its Impact on Space Activities
- Plenary 2:** Sustainable Development Goals (SDG) and the Contributions of Satellite Communications
- Plenary 3:** Space Economy meets Information Economy
- Plenary 4:** Space Services and Security
- Plenary 5:** Big Data – Information Society

In addition to these plenaries, A SpaceUp session

for young professionals and students was organized the day prior to the conference.

The conference was very well appreciated; the participants enjoyed the networking possibilities and the high-level presentations on very specific topics. Below can be found some of the main recommendations and conclusions from GLIS 2016:

- The border between space and ICT is fading and the focus is on specific services and information provided, regardless if the infrastructure is space or terrestrially based;
- Operators are facing challenges due to fragmentation of national policies and regulations; harmonization and barrier removal are strongly needed;
- Some regulatory limitations in securing spectrum for space activities still exist and enhancements would be required in particular for a more transparent application by individual administration;
- There is a clear need to bring Europe’s know-how online with Copernicus and other Space data. Free, full and open data policies are seen as essential in this context;
- The issue of privacy and protection of personal data raises increasing concerns;
- The Space community must start working on compounding the benefits of the different space technologies to offer integrated applications of satellite based Earth Observation, global navigation, satellite systems and satellite telecommunications.

# IAC 2016

## OVERVIEW

The **67<sup>th</sup> International Astronautical Congress** held in Guadalajara last September was a resounding success, with a record number of **5,217** delegates and an exciting technical and plenary program with top-level speakers. One of the main themes of the last IAC was the discussion on Mars, led by NASA (Charles Bolden), SpaceX (Elon Musk) and Lockheed Martin (Tony Antonelli and Rob Chambers).



# IAC 2016

## Plenaries



### Plenary 1: Heads of Agencies

New rockets, spacecraft, launch sites, more collaboration, robots and astronauts on the Moon were some of the many activities the heads of space agencies described in the plenary session and the following press conference, held on Monday 26 September.

Russia, China, Japan, the USA and India are all putting into operation new rockets, imminently and in the next few years. China will launch its new generation Long March 5 rocket in November 2016 from its new Hainan island launch centre. In 2020, Japan expects to launch its new H-3 rocket. India has a more powerful version of its Geosynchronous Satellite Launch Vehicle Mark III rocket taking off in 2017. During the heads of agency press conference after the plenary session, Indian Space Research Organisation's (ISRO) Liquid Propulsion Systems Centre Director, S. Somanath, said that India intended to transfer rocket production into private companies.

In the USA, NASA is working towards the 2018 first launch of its heavy lift Space Launch System rocket, which can put 70 tonnes into orbit. Russia launched its first Angara rocket in 2014 and plans to launch a larger version in the next few years. To do this, Russia has planned a second stage to the development of its new Vostochny spaceport in the Far East of Russia. This further development of Vostochny will cater to the larger versions of the Angara launch system which from the early 2020s will fly manned missions.

The manned missions from Vostochny will use the new generation spacecraft that Russia has in

development, called Federation. It replaces Russia's current Soyuz spacecraft. Federation will have an unmanned test flight in 2019 and then a manned test flight, to the International Space Station (ISS), in 2021. Before Federation flies, NASA expects to be paying for Boeing and Space Exploration Technologies (SpaceX) to fly astronauts to the ISS from 2018 in their respective spacecraft. Those launches will be from NASA's Kennedy Space Centre. NASA administrator Charles Bolden told the heads of agency press conference that he expected unmanned test flights of Boeing's Starliner and SpaceX's Dragon V2 next year.

China's astronauts fly on the Shenzhou spacecraft. WU Yanhua, Vice Administrator of the China National Space Administration (CNSA), told the plenary session that the eleventh Shenzhou XI manned spacecraft mission was expected to launch in 2016. In 2017, a new unmanned Chinese spacecraft, described as "China's ATV" by WU, will be launched to dock with a Chinese space station module. The acronym ATV refers to the European Space Agency's cargo spacecraft, the Automated Transfer Vehicle, ATV, which is no longer used.

All those spacecraft and rockets and launch sites are all



contributing to a flotilla of space probes going to the Moon and Mars. Some of these are national missions and others are international, but some of the individual agency missions still have scientific instruments from other countries.

Bolden described the next phase of exploration as developing the technologies to make missions independent of Earth, able to go to the Moon and Mars beyond low Earth orbit. He also talked about how individual agency's missions could bring data together for a greater understanding of the solar system, citing the ongoing Indian and American, and future United Arab Emirates' (UAE), analyses of the Martian atmosphere. Three agencies, three probes, each studying a different part of the atmosphere, so they can all understand the whole environment. The UAE probe is yet to be launched.

China's Chang'e 4 mission to the far side of the Moon will have other countries' instruments on-board. Chang'e 4, a lander, will use a data relay satellite. China will send to the Langrangian point 2 orbit location, beyond the Earth and the Moon, so that the dark side of the moon can be monitored. Chang'e 4 was the backup model of the Chang'e 3 lander that successfully landed on the near side of the Moon in 2013.

Roscosmos, now a Russian government owned company and not legally a space agency, sees a multinational effort for robotic and manned exploration of the Moon, along the same lines as the European Space Agency's Moon village

concept. ESA Director-General Jan Woerner described the village as a concept of collaboration of robots or astronauts or both, and not literally a village, like a small settlement. Roscosmos head, Igor Komarov, agreed and added that the Moon was a priority for Russia and it would be informing ESA and NASA of its plans. China plans for more Moon and Mars robot missions, like its Chang'e missions. Its government has approved a Mars mission with an orbiter, lander and rover, which is to be launched in 2020.

During the plenary session, six of the eight questions co-moderator and Executive Director of the Space Generation Advisory Council (SGAC), Minoo Rathnasabapathy had, were about encouraging and nurturing talent. All the agencies are involved in encouraging pupils and students to take up science, technology, engineering and maths (STEM). Bolden praised the work of the SGAC and the other agencies spoke about astronauts taking a leading role in promoting space and STEM.

Those new scientists, engineers, astronauts, will be needed as the space agencies have a great deal of new rockets, spacecraft to launch and exploration to do. According to ESA's newly released public opinion research they broadly have the support from their nations' populations to do it all. Komarov added that success shows the people space exploration can, "get good results," and that will help the realization of future programmes.





## Plenary 3: Space and Climate - How Space Agencies Will Contribute to the Implementation and Follow-up of the Paris Agreement during COP 21

### Plenary 2: Satellite Communications Making Connectivity Accesible and Affordable to Latin-American Countries to Reduce the Digital Divide

Developing nations' space agencies should federate in their region and make more use of available space based data, the Global Networking Forum's Space Technology for Emerging Countries for Latin and South America session was told.

Many emerging economies have a need for data that will help their agricultural industries and their governments' resource planning, as well as disaster management. The session heard that countries often do not know that data from satellites, such as Landsat, is freely available. While communication is ongoing between countries a lot more can be done. Only a handful of the Latin American (LatAm) and South American countries, for example, have any real history of space programmes and their own satellites.

Joerg Feustel-Buechl, an advisor to the economy ministry of the German state of Bavaria, told the session: "It would be very nice to see an organisation that coordinates and federates the efforts of Latin, South America. A LASA, Latin American Space Agency, would help." He saw difficulties for emerging countries worldwide to make the most of space on their own and that the pooling of their resources would enable them to do more. He also recommended an African space agency for that continent's 50 plus countries.

The United Nations' Office of Outer Space Affairs (UNOOSA) provides support, including training, for countries that want to build a capacity to use space based resources. It has been working with countries across LatAm and South America including, Barbados, Ecuador, San Salvador, Colombia and Dominican Republic. UNOOSA Director, Simonetta Di Pippo, told the session that her office was working with a range of LatAm and South American countries through the Space-

based information for Disaster Management and Emergency Response (UN-SPIDER) programme. It exists to help countries use space based data to support disaster management. In September, UNOOSA announced that Mexico was the latest country to sign a Cooperation Agreement to have a Regional Support Office for UN-SPIDER.

In the session, Mexican Space Agency Director, Francisco Javier Mendieta Jiménez, explained that his country is linking up with nations that are already operating in space, such as Brazil and Argentina. Mexico hosted a summit that included, Costa Rica, Ecuador, Nicaragua, and Venezuela. Disaster management is a key area with early warning systems and information dissemination being important elements. The countries are focusing on space based information gathering, its processing and dissemination, the necessary infrastructure, such as ground stations, that they need and alliances with space faring countries, Jiménez added. He also cited Peru as an example of a country making progress as it has recently had launched its first Earth observation satellite.

At the International Astronautical Congress in Guadalajara, UNOOSA announced that it intends to pay for a space mission using the Sierra Nevada Corporation's Dream Chaser spaceplane. The mission would allow developing countries to fly microgravity payloads in orbit for 14-days. Dream Chaser is being developed by Sierra Nevada in cooperation with NASA. Dream Chaser would launch on a United Launch Alliance Atlas V rocket and return to Earth, gliding to a landing runway. The UNOOSA mission is planned for 2021, but Dream Chaser has yet to launch. In June, Sierra Nevada and UNOOSA signed a Memorandum of Understanding.

Earth observation from space is the only way to provide consistent collection of more than half of the variables that are used to measure climate change, the third plenary heard.

From ice loss to sea level rise, vegetation growth and carbon dioxide (CO2) concentrations in parts per million, space agencies from Mexico to India described their observation capabilities during the Space and Climate: How Space Agencies Will Contribute to the Implementation and Follow-up of the Paris Agreement during COP 21? Plenary session on Tuesday 26 September.

The plenary was opened by International Astronautical Federation president-elect Jean-Yves Le Gall, and he stated that of the 50 variables used to measure climate change, 26 can only be observed globally and continuously from space. Le Gall warned of the dangers of climate change, he said: "Extreme weather events are the plagues of our modern day."

The effect of extreme weather is that populations are displaced and Italy thinks mobile phones could help people prepare. Roberto Battiston, President of the Italian Space Agency, told the plenary that mobile phones, widespread in Africa and elsewhere, could have applications that provide warnings about river levels, where flooding could be a problem. For agricultural communities, satellites can also provide helpful weather information and the European Space Agency's Director-General, Johann-Dietrich Woerner, outlined how observation data can tell farmers where and what to irrigate. He also pointed to

experiments on the International Space Station (ISS) that are helping to develop drought resistant plants.

What will help warn humanity of what is to come is measuring the levels of CO2 in the atmosphere. The plenary heard from the Japan Aerospace Exploration Agency and NASA about satellites that are and will be measuring CO2 levels. Naoki Okumura, President of JAXA, pointed out that Japan has had a CO2 measuring satellite, called Ibuki in Japanese or GOSAT, Greenhouse gases Observing Satellite, in English, operating since 2009. JAXA analysed its accumulated GOSAT data for Tokyo's metropolitan centre to calculate anthropogenic CO2 concentrations. That showed that satellites can verify ground observations. In 2018, JAXA is to launch GOSAT-2 and it will have a much higher sensitivity to CO2 levels.

NASA has had its Orbiting Carbon Observatory 2 (OCO-2) satellite in orbit since 2014. Ellen Stofan, NASA Chief Scientist, explained that, "we are starting to get a handle on how we see carbon as a changing component of the atmosphere, seasonally, yearly. What are the sources and what are the sinks? Half of the CO2 in the atmosphere doesn't stay there. Where does it go?" Stofan added that NASA knew that CO2 does go into the sea. The next OCO platform will be attached to the ISS and the one after that.

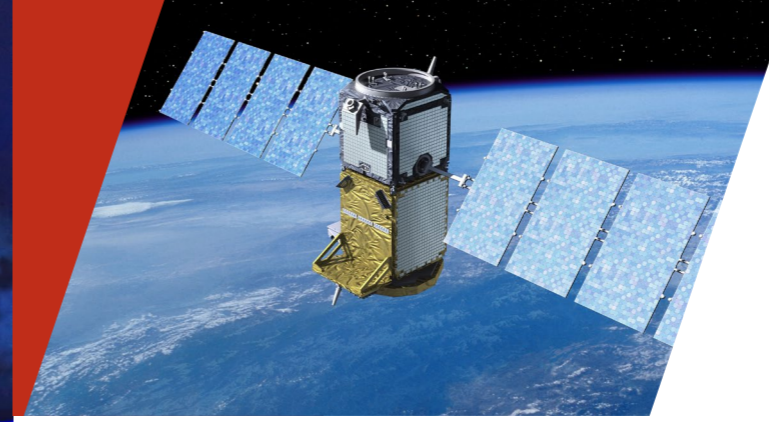
During the plenary another agency that spoke of their substantial Earth observation was the Indian Space Research Organisation. India is also now working with Mexico. Francisco Javier Mendieta Jimenez, General Director of the Mexican Space Agency, said that last year the President of India visited Mexico and, "presented climate change as a joint challenge," for the two countries. International collaboration has been and will continue to be a dimension to the investigation into climate change and what it means for the planet, with the space agencies working at the coalface of key data collection.

**Global Challenges**

- climate change
- migration
- mobility
- communication
- energy
- shortage of resources
- demographic development
- conflicts and catastrophes
- health
- ...curiosity

→ **Space:**  
information, communication, science, technology, education, inspiration...

esa



## Plenary 5: Living For a Whole Year on ISS - Early Results and Lessons Learned #YearInSpace

## Plenary 4: Innovative Solutions for Making Space Accessible and Affordable – Next Generation PE



The many terrestrial applications for space technology was driven home during the Innovative Solutions for Making Space Accessible and Affordable – Next Generation plenary session, along with the ability of non-space inventions to aid exploration.

From Moon rovers being used to investigate radioactive sites to Earth observation data for disaster relief involving drones and implanted medical devices for astronauts, the next generation of entrepreneurs had a wide range of ideas about how their business ideas could help humanity.

Rovers from Google Lunar X Prize entrant ispace technologies were used to inspect the Fukushima nuclear power plants after the disaster there. People could not go there because of the radiation, Kyle Acierno, Global Business Development Manager for the company, told the audience. The rovers have also been used around Volcanoes. Acierno explained that one concept for lunar rover exploration was a “a swarm” of the vehicles going into caves to evaluate their potential use as habitats and drilling to study the local geology.

Rovers are wheeled or tracked vehicles whose technologies are widely established and design tools are available. Designing a satellite requires software tools that not as widely available, but at Venezuela’s Bolivarian Agency for Space Activities there is work to create accessible software. Bolivarian Agency for Space Activities’ Electrical Power Supply Design Engineer, Elyka Abello, spoke of their work on developing a system level design

tool for electrical power verification, checking that there is enough power from solar panels, for example. The goal is to have design tools that will allow emerging countries to design their low-cost satellites.

Data from satellites for emerging economies is the basis of the business model for Fusion Space Technologies. Its Chief Executive Officer, Sinead O’Sullivan, a Harvard Business School Fellow, would like to partner with NASA, the European Space Agency and companies like Earth observation firm Planet, to provide such data. O’Sullivan’s company offers integrated data from drones and satellites. O’Sullivan’s company is creating the first ever platform for crowdsourced drone data. By integrating this with satellite imagery, her firm is producing ultra-high resolution imaging at a high refresh rate.

As well as data, satellites are envisaged to transmit power down to Earth in the future. These space based solar power (SBSP) satellites would use lasers or microwaves to send the energy down to a ground station. Marek Novák, a research student researcher and medical entrepreneur at Czech Technical University in Prague, has designed hardware that can study the performance of the SBSP ground segment for about USD\$200, a fraction of the thousands that he says commercial systems cost. This device also has medical applications. Because Novák has worked in the medical research he saw an opportunity to apply the technology to the diabetes market to help the world’s 400 million diabetics.

High levels of carbon dioxide may be causing some physiological effects seen in microgravity, while current astronaut exercise regimes should be sufficient for a Mars trip, the US-Russian year in space experiment has found.

Russian cosmonaut Mikhail Kornienko, NASA Associate Administrator for Human Exploration and Operations, William Gerstenmaier and Michael Stenger, a NASA Human Research Program scientist and Cardiovascular Laboratory Lead at Wyle Laboratories, spoke about the results in the Living For a Whole Year on ISS: Early Results and Lessons Learned plenary session.

Kornienko spent 340-days on the International Space Station (ISS) along with NASA astronaut and Expedition 46 Commander Scott Kelly. Kornienko and Kelly landed back on Earth on 2 March.

Gerstenmaier told the plenary session that the decision to do a one-year study was because of the decision to go to Mars and to answer the question, what happens after 180 days? That was the maximum amount of time a US astronaut has flown from past ISS missions.

Kornienko said that he found he recovered faster after this longer mission and that his recovery process was much easier. “It was very good experience for next missions, I can suggest how you can go to Mars or Moon, for long duration flight,” he said. The day after his landing Kornienko was in a centrifuge for a controlled Soyuz spacecraft descent simulation and he passed the test. A few days after that he was in a pressure suit practising Mars gravity operations.

Stenger explained that because the ISS crews do two hours of exercise a day they often gain

heart and skeletal muscle during the flight returning healthier than when they left. However, the ISS environment has no benefits for the eyes. Stenger’s area of interest is fluid shift in the body. In microgravity fluid in the body moves upwards. This was thought to be the cause behind permanent shape changes seen in some astronauts’ eyes. Other theories about what causes the eye changes are, the high sodium diet, astronauts’ food has more salt to counter the loss of taste experienced in microgravity, and radiation. Gerstenmaier identified the fact that the ISS air has 10 times the level of CO2 in it that sea level Earth’s has as a possible cause for the eye changes.

Gerstenmaier spoke of future one-year missions as potentially involving women and that astronaut isolation would also need to be incorporated. Being able to see the Earth close by is a comfort for astronauts and they will not have that on a Mars mission. In an answer to a question about the use of artificial gravity he said that NASA had looked at spacecraft designs that incorporated artificial gravity of 1 g but that, “the way it is done in the movies, it doesn’t work it’s a major redesign.”

Kornienko added that he thought that existing “countermeasures,” such as the crew exercise regime was adequate.



## Plenary 6: Realizing Mars Sample Return through Human and Robotic Collaboration

After orbiters, landers and rovers on and around Mars, speakers of the sixth plenary, Realizing Mars Sample Return (MSR) through Human and Robotic Collaboration, said the time was now to launch the MSR effort.

The first steps in the campaign for MSR were being taken and if countries, other than the established space faring nations of Russia, the USA, China and the Europeans, wanted to join it should be soon, according to the European Space Agency's (ESA) Director of Human Spaceflight and Robotic Exploration, Dr David Parker. He named India and the United Arab Emirates as countries that could join an MSR effort and that if they were to get involved, "[it] is something we need to do pretty soon."

The biggest challenge now for an MSR mission was not so much the technological capabilities, which are understood and implementable, but simply choosing the sampling sites and what samples to take. This is the view of NASA's Mars Program Formulation Office Manager, Charles Whetsel. What has been decided at NASA is that hundreds of grams consisting of 30 samples should be brought back.

The technology elements of MSR are well understood and the Mars missions that have taken place and planned for, have and will test equipment that would be used for returning a sample. Whetsel identified, an accurate landing capability, the ascent vehicle, a sample fetching rover, auto rendezvous, the on-orbit capture of the ascent vehicle, and a safe Earth return, as technologies needed for MSR. Each of these technologies could be provided by different partners, both space agencies and industry. He added that MSR practices all of the elements of a human mission to Mars.

Whetsel also said that the sample returning spacecraft could rendezvous with a manned vehicle, such as NASA's Orion, in cis-lunar space. Bringing back the samples on a proven crew return vehicle with would show people it is safe, he said.

One question to the panel was about Space Exploration Technologies' founder Elon Musk and his plans for a fully reusable Mars ship. Parker said that if Musk achieves to create his transportation system it, "creates enormous science possibilities". He added that ESA was keen on working with entrepreneurs.

Technologies in development and already operational by ESA can be used for MSR, Parker explained. He cited the solar electric propulsion propelling ESA's BepiColombo mission to Mercury and the return capsule, rover electronics, sample capture and sample sealing systems that his agency has invested money in developing.

Some of these technologies could be applied to the Phobos sample return mission that ESA has had industry carry out early studies on, called phase A. The phase A study confirmed ESA could carry out its own Phobos sample return mission and Parker said: "My personal view is, let's do it." The Japan Aerospace Exploration Agency (JAXA) is doing a Phobos sample return mission. JAXA's Department of Solar Systems Sciences Director, Dr Masaki Fujimoto, told the plenary's audience that his agency's mission would be launched in the 2020s. The spacecraft would reach Phobos, inspect it for a sampling site decision and land for a few hours to take a sample, before returning to Earth. Fujimoto said that the mission would be the first to be captured by Mars' gravity and return to Earth. On its way back, the spacecraft would fly-by Mars' other moon, Deimos.

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 (CO-SPAR) should play a large role. "CO-SPAR is an entity that over 50 years, maybe 60, has helped coordinate science cooperation between countries and we could expect CO-SPAR will play a big role in the exploration of Mars and the science coordination, as many countries ramp up Mars exploration programs."



## Plenary 7: Projection and Stability of the Orbital Debris Environment in the Light of Planned Mega-Constellation Deployments



Even if every spacecraft launched for the proposed mega-constellations in low Earth orbit (LEO) adhere to all the orbital debris mitigation requirements there will still be almost 40,000 fragments larger than 10 centimetres by 2070, but if 50% of satellites do not, the number of objects will increase by 50% every 50 years for the foreseeable future.

The European Space Agency's Space Debris Office head, Holger Krag, said that adhering to the debris mitigation policies was a big responsibility for the large constellations. Two companies, OneWeb and Space Exploration Technologies, are proposing mega-constellations of potentially thousands of Internet telecommunication satellites in LEO. Debris mitigation methods are, avoid collisions, have a planned graveyard orbit when the spacecraft's useful life ends and limit mission generated debris, such as deployment related rocket parts. Krag pointed to ESA's experience of its Sentinel-1A satellite which is at 693 kilometres (km) altitude, in LEO, and was struck by a tiny piece of manmade debris. The debris damaged its solar array reducing the array's ability to collect solar energy.

NASA Chief Orbital Debris scientist, Jer-Chyi Liou, told the plenary that at the altitudes of 1,100km to 1,200km there is little atmospheric drag and any debris in that region will stay there for thousands of years or longer. Liou pointed out that there are 4,000 spacecraft circling the Earth, but only 1,400 are operational, the rest are orbital debris. With the proposed mega-constellations, thousands of spacecraft will be added increasing their orbital number to 7-8,000. Liou expected that such a number would make it difficult for authorities to

monitor spacecraft and analyse all their possible collisions that could generate debris. He pointed out that if each mega-constellation satellite was 150 kilograms (kg) in size the constellations would also add 20% to the total mass of spacecraft in orbit, increasing it 3,300 tonnes.

OneWeb's Mission System Engineering and Analysis Lead, Michael Lindsay, told the plenary that its 150kg Internet telecommunications satellites will operate in 18 planes at 1,200km and an inclination of 87.9 degrees. The first stage for the mega-constellation will be to have 648 satellites orbited with 36 spacecraft per plane. With Airbus, OneWeb has created a joint venture based in Florida to build an initial order of 900. Lindsay said that more than the initial 648 spacecraft would be orbited if there was customer demand. The satellites will have the ability to deorbit themselves and each spacecraft would have deorbited about five years after they are decommissioned. He also explained that the satellites will broadcast their position and will be manoeuvrable to avoid any possible collisions. OneWeb has contracts with Arianespace to launch more than 600 satellites using 21 Soyuz rockets. The mega-constellation firm has also placed launches with Virgin Galactic and its LauncherOne rocket.



# IAC 2016

## Highlight Lectures

### Highlight Lecture 1: Mars Base Camp

Humans going to the red planet in the 2030s could see their Mars ship assembled near the Moon and then that spacecraft added too once it is in orbit to become a Mars Base Camp, Lockheed Martin Space Systems' advanced programs staff, Tony Antonelli and Rob Chambers told the Mars Base Camp highlight lecture.

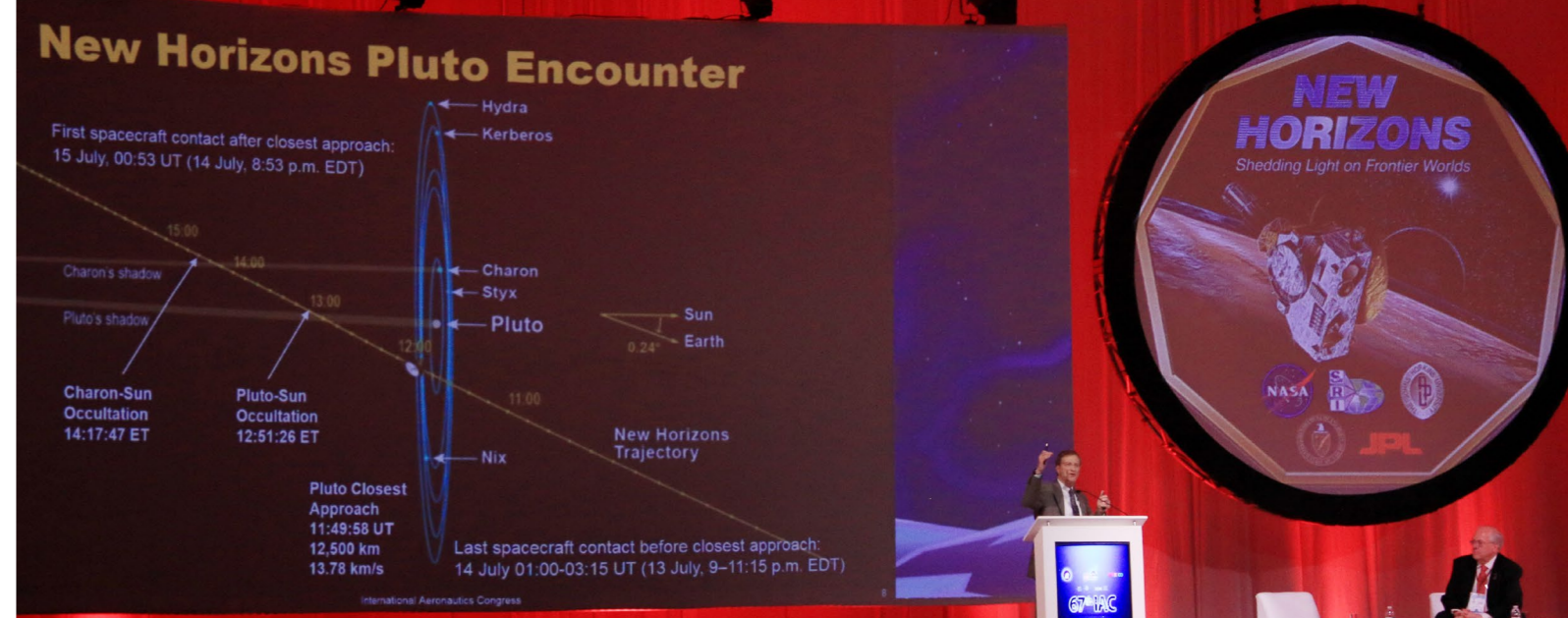
The Mars transfer spacecraft is assembled in cislunar space, between the Earth and the Moon, with a habitat, two Orion capsules, and a liquid oxygen and hydrogen propulsion system. After a nine-month flight to the red planet, for a 1,000-day total manned mission, this Mars ship will dock with a 7.5 tonne laboratory, and other systems, which would have been sent to Mars previously. The laboratory and what is called an excursion system, an Orion capsule and in-space propulsion module, would have been sent earlier using solar electric propulsion. All of these elements of the Mars ship would have been launched from Earth by NASA's Space Launch System, a Saturn V-like rocket expected to make its first test flight in 2018.

The new enlarged ship becomes what Lockheed calls the Mars Base Camp. This camp has a high elliptical orbit of Mars to allow for excursions to the moons of Mars, Phobos and Deimos, and to drop exploration vehicles anywhere on Mars' surface. The base camp ship would take one Martian day, 24 hours and 39 minutes, to orbit the red planet. Chambers explained that the laboratory would provide all the equipment necessary for science and the astronauts would use tele-robotics for surface exploration.



Antonelli described how astronauts would control unmanned air vehicles (UAV) to scour the Martian surface for sites that could harbour life or fossils. The UAVs, and rovers, would be controlled by astronauts using virtual reality created from three-dimensional imagery transmitted back to the base camp. A UAV could be flown through the methane clouds on Mars emanating from the surface to discover what produces this gas, which is closely associated with life. A rover could dig up fossils for samples to be later sent to the base camp before it's crew return to Earth. The UAV could also help identify future human landing sites. There are already many potential human landing sites identified, Chamber explained, and base camp would enable a better understanding of which were the better sites.

Antonelli also talked about astronauts leaving the orbital base camp and going to Phobos and Deimos with the excursion system. The in-space propulsion they would use is new technology that will have to be developed to be very reliable, Antonelli explained. Lockheed Martin Space Systems civil space vice president, Wanda Sigur, was the lecture's moderator. Sigur said that the base camp mission could be done now, by this generation and is not something that needs to be left to the next generation.



### Highlight Lecture 2: The Exploration of Pluto by the New Horizons Mission

Pluto may not officially be a planet anymore, but it has moons and there is a Pluto system which points to a violent history and a very different solar system in the distant past.

The audience for the Highlight Lecture 2: The Exploration of Pluto by the New Horizons Mission learned that the Pluto system, its largest moon, Charon, and its recently discovered other moons of Hydra, Nix, Styx and Kerberos, was created by a collision between two, "Pluto sized objects." The Johns Hopkins University Applied Physics Laboratory research professor and New Horizons mission's Project Scientist Harold Weaver told the session that the fact that the moons were, "all in the same plane and almost all in a circular orbit," means the objects formed from a disc of post-collision debris.

Weaver explained that Pluto is now viewed as a "typical member" of the Kuiper belt, which consists of icy objects orbiting the Sun beyond Neptune and named after the Dutch-born astronomer Gerard Kuiper. He suggested in 1951 that some comets may come from this region. The Kuiper belt's formation requires, "extensive radial migration of giant planets in the early formation of the solar system," according to Weaver. Jupiter may have come in as far as Mars' orbit and moved back out again and Uranus and Neptune might have changed places.

Launched in 2006, the New Horizons spacecraft, which is about the size of a baby grand piano, flew

by the Pluto system in mid-2015. New Horizons uses a radioisotope generator for power as there is not enough sunlight at the distance of Pluto, 30 astronomical units. On its journey, New Horizons gained a gravity assist with a flyby of Jupiter, increasing its speed by 20%, reducing the travel time by three years.

New Horizons discovered a planetoid that geologically looks like a planet and has molecular nitrogen ice that acts like water despite the sunward side of Pluto being a cold 38 Kelvin. Originally found in 1938, Pluto is now known to have a grey and white colouring, peaks as high as the Rocky mountains and a white area consisting of molecular nitrogen ice. This ice fills an impact basin caused by a large object that struck the planetoid about 4 billion years ago. The basin is called Sputnik. Polygonal structures seen across the basin could be caused by deeper geothermal heating that forces molecular nitrogen ice to undergo upwards and downwards solid state convection. Weaver described the Sputnik basin as like a, "lava lamp". There is also evidence of cryo-volcanism on Pluto. Another feature of Pluto, a dark belt, is thought to be caused by heavy hydrocarbons on the surface that have been coloured by exposure to cosmic radiation.

New Horizons work has not finished. It is to flyby a primitive Kuiper belt object in January 2019, passing by at a distance of 3,000 kilometres, four times closer than its Pluto encounter.

## Highlight Lecture 3: The Saturn System as a Natural Laboratory to Investigate the Emergence of Biology

Next year NASA may choose to send a spacecraft to fly through the water plumes of Saturn's moon Enceladus and it might detect indications of life, the third highlight lecture was told by the mission's proponent Dr Jonathan Lunine.

Mass spectrometers on-board the Cassini spacecraft, which arrived in the Saturnian system in 2004, have already detected organic molecules and salts after passing through the plumes seven times since 2008. In the Highlight Lecture 3: The Saturn System as a Natural Laboratory to Investigate the Emergence of Biology session, Lunine said: "Enceladus could have life and we know how to search for life there."

Cassini's mass spectrometers have determined that the water plumes that are seen coming from some of the south pole's estimated 100 fractures contain methane, ammonia, carbon dioxide, nitrogen, hydrogen and carbon molecules. The spectrometers were unable to detect carbon molecules associated with life because they are not accurate enough. The new mission's more advanced spectrometers would.

The spectrometers have also detected sodium and potassium salts and the grains of plume ice have

a salinity of 2%. This salinity means the salts were dissolved in water before the ice formed. This is one indication of an ocean beneath Enceladus' surface of ice. Another indicator is the silica that is also detected as a colloidal suspension. Enceladus is thought to have a silica core and the ocean's water, heated from Saturn gravity induced tidal forces and radiogenic sources at the moon's centre, would flow through silica fractures; picking up material, which is subsequently ejected in the plume.

The other indicators are not from the spectrometers, but an analysis of Enceladus' orbit of Saturn. Lunine explained that a phenomena seen in the Earth's Moon, nodding, is also detected at Enceladus. The Saturn moon's nodding is frequent enough that it must be caused by an ice shell and not the mass of the entire planetoid. The nodding indicates the shell is moving over a global ocean.

The acidity of the Enceladus ocean is also not hostile to life. Cassini data suggests that it is a "very alkaline ocean," according to Lunine. It has a pH value of 10-12 and Earth's oceans' hydrothermal systems have pH values of about 10.

# IAC 2016 Late Breaking News

## Making Humans a Multiplanetary Species



## SpaceX founder Elon Musk reveals Mars colonisation plan

A fully reusable two-stage rocket taller than the Saturn V with methane as its fuel and liquid oxygen is Space Exploration Technologies' (SpaceX) transportation vision for Mars colonisation.

Launched from NASA's Kennedy Space Centre space launch complex pad 39, the two-stage rocket has a booster with 42 Raptor engines and the colonist carrying spaceship atop it. A Raptor engine was successfully tested a few days before Musk's speech. The booster returns to pad 39 after putting the spaceship into orbit. The spaceship is then met by a refuelling spaceship as it launches with almost no fuel, but 100 passengers. The fuelled spaceship will then accelerate to reach Mars in 80-days. The Mars flights would only launch during the six-month window that occurs every two years and the planets are at their closest.

SpaceX founder, Elon Musk, described what he calls the Interplanetary Transportation System during an hour long speech on Tuesday 27 September to a packed plenary hall session. He explained that he expected the ticket price would be \$200,000 per colonist. In the press conference later he said SpaceX would not be soliciting advance ticket sales until a more accurate cost and spaceship reliability figures were known.

Musk's vision is a self-sustaining Mars city of a million people, which begins with a refuelling plant on the surface and each spaceship arrival

delivering more and more equipment to realise the new community. He said it was up to the colonists how they built their community and referred to letting a "thousand flowers bloom".

The spaceship's design would allow it to decelerate as it entered the atmosphere and then it would fire its engines for a propulsive landing, like SpaceX's Falcon 9 rocket. Like the booster, the spaceship would use Raptor engines. Once on the surface, the spaceship would be refuelled with methane and oxygen produced from local resources.

SpaceX has developed its Dragon spacecraft which sends cargo to the International Space Station and a crewed version, the V2, will take astronauts to the International Space Station from 2018. At the press conference, Musk explained that a Mars mission version called Red Dragon will be sent to the red planet on pathfinder missions to understand navigation, deep space communications and the atmosphere. The Red Dragons will land on Mars, but Musk only gave them a 50% chance of touching down successfully.



# IAF Global Networking Forum (GNF)



## The Development of Commercial Remote Sensing Satellites and LEO Communication Constellation

China has plans for future high resolution imaging satellites and the use of synthetic aperture radar for Earth observation, as well as opportunities for student payloads.

Speaking on the first day of the 67th International Astronautical Congress, Dr. Lihua Zhang, Project Manager for Chinese small satellite manufacturer, DFH Satellite Co.,Ltd, outlined goals for China for the next few years in satellite technology. China foresees constellations of high resolution optical and radar satellites providing imagery on a commercial basis. But, China has already sold an optical Earth observation satellite commercially, to Venezuela, the VRSS-1 satellite.

Zhang's company is building four satellites for a proposed Chinese constellation. DFH has produced small satellites for 15 years and has more than 500

employees. In 2015, the China Aerospace Science and Technology Corporation (CASC), which DFH is a subsidiary of, announced the start of construction for a 28-spacecraft commercial constellation. Four of these are DFH's spacecraft. The first of the 28 are expected to be launched later this year and in 2017.

Beyond the commercial work, Zhang described the XW-1 spacecraft, which is China's first satellite that is available to carry students' payloads. In 2018, he said, an Ocean monitoring satellite which is a joint project between China and France and uses the Chinese CAST2000 platform, will be launched. Another mission using a DFH/CASC satellite is the Chang'e 4 mission which will put a CE-4 satellite into the Langrangian point 2 orbit to relay data from the mission's lander.

## Russian Cosmonautics - International Aspects

Russia's plans for manned space missions were set out by the General Director of Energia, the country's developer of human rated spacecraft and rockets at the 67th International Astronautical Congress in Guadalajara, Mexico.

Energia's General Director, Vladimir Solntsev, set out a programme of activity extending from now

until the 2030s. Next year the multi-purpose laboratory module (MLM) will be launched to the International Space Station (ISS). This year its production is being completed. In 2019 a scientific power module and a node module, which allows larger modules to be attached, called Node Two, will be launched. The scientific power module has solar panels to provide power for itself and other

station modules. They too are being manufactured at the moment. They will be launched on a Proton rocket.

Solntsev said that if the ISS partners do not decide to continue using the ISS beyond 2024, those modules will form the Orbital Russian Station. He added that if the station does start operating from 2024, other nations are welcome to participate in its use. Solntsev confirmed that Russia was talking to China about space station collaboration and new rockets.

He also described a cis-lunar station that could

be an international collaboration. Referring to proposals from other agencies, Solntsev described a space station between the Earth and the Moon, cis-lunar, that uses a solar electric propulsion tug for cargo delivery. Solar electric propulsion uses solar power to drive its propulsion system. While no firm date is given for this international cis-lunar station, Solntsev set the date of 2025 for Russia's circumnavigation of the Moon by its new Federation manned spacecraft. The lunar mission would be launched by a new heavy lift launcher able to put 100 tonnes into low Earth orbit. The new heavy lift rocket and Federation would also serve the cis-lunar station.

## INDUSTRY DAY

### Virgin Galactic

### Virgin Galactic spaceship to make first glide flight

Virgin Galactic's latest SpaceShipTwo called Unity will make a glide test flight when it next flies, the spaceline's Chief Executive George Whitesides told the Global Networking Forum on Tuesday 27 September.

Unity had its first captive carry flight on 9 September this year. Virgin Galactic calls its reusable spaceplane SpaceShipTwo (SS2), after the SpaceShipOne (SS1) which won the X Prize for reusable spaceflight in 2004. Virgin Galactic plans to have a fleet of SS2s. Unity is the second SS2 to be built after the loss of the prototype, Enterprise, which broke apart during a test flight in 2014. Unity was built by Virgin Galactic's sister company The Spaceship Company. Enterprise was built by SS1 developer Scaled Composites, Virgin Galactic's development partner for the SS2.

Whitesides said: "Our next flight will not be a captive carry flight it will be the first flight." He added that the glide flight would occur sooner rather than later.

SpaceShipTwos are launched by a carrier aircraft, known as WhiteKnightTwo, at an altitude of about 50,000 feet. The SS2 will fire its rocket motor and the spaceplane reaches an apogee of just above 100 kilometres. Its six passengers and two pilots will then experience microgravity for a few minutes before the return to Earth. Announced by Virgin Galactic owner, Sir Richard Branson, in 2004, after the SS1 X-Prize win, the spaceline plans to operate from Spaceport America in New Mexico.





## Blue Origin

### Blue Origin to test escape rockets

Future test flights and rockets were set out by Rob Meyerson, President of Blue Origin, a company which has had recent success with a reusable sub-orbital booster.

Meyerson's presentation described the company's work towards a sub-orbital space tourism launch system called New Shepard. It is named after NASA astronaut Alan Shepard who was the first American into space, but not into orbit. In April, Blue Origin successfully flew the same New Shepard launch vehicle for the third time.

In October, the company is going to undertake a capsule escape system test. This will see the six-person capsule, launched by the New Shepard booster, fire solid rocket motors which are the escape system, to separate the capsule from the launcher. The solid rocket motors provide 70,000lb of thrust in a two-second burn. In 2012, the firm carried out a successful capsule launch pad abort test.

Meyerson explained what will happen during the October test: "Forty-five seconds after lift-off, at 16,000 feet altitude...the escape motor will steer the capsule to one side to avoid the booster." The capsule uses three parachutes to return to Earth along with a propulsive landing motor to soften the touchdown.

Blue Origin has plans for larger orbital reusable boosters. Earlier in September, Blue Origin announced in a newsletter that its orbital rocket would be called New Glenn, after John Glenn the first American to be sent into orbit. There will be two versions of the New Glenn, one with two-stages and one with three. The three-stage version is almost as tall as NASA's Saturn V rocket and it would lift payloads that could travel beyond low Earth orbit. The newsletter also hinted at a larger rocket, which Meyerson also alluded to, called New Armstrong.

## Arianespace

### Ariane 6 to replace Soyuz in French Guiana

Ten years after it first flew from Europe's spaceport in French Guiana, Russia's Soyuz rocket could cease to operate from the equatorial territory when Arianespace's Ariane 6 starts launching from 2020.

Speaking at the Global Networking Forum on Tuesday 27 September, Arianespace Sales and Business Development Senior Vice President, Jacques Breton, said: "[Ariane 6] will replace the Soyuz." He also explained that the new rocket will replace his company's Ariane 5 that has performed more than 75 missions since its introduction in 1999. Ariane 6 has two versions, the A62 and the A64. The versions differ by the number of solid propellant boosters they have. The A62 has two, the A64 has four. These boosters are the P120 which is being used for Arianespace's Vega C rocket's first

stage, an improved version of the earlier Vega, which also had a solid propellant first stage. Both of the Ariane 6 versions have a main stage fuelled by liquid oxygen (LOX) and hydrogen and an engine which is based on the Ariane 5's Vulcain engine. Their upper stage uses LOX and liquid hydrogen and is powered by a Vinci engine.

The 62 provides a similar performance to the Russian Soyuz, able to launch three tonnes into a sun synchronous orbit, while the 64 is about as capable as the Ariane 5, which could put 11 tonnes into geostationary transfer orbits. Arianespace aims to have five launches a year of the A62 version and six of the A64. They will launch from a new launch pad to be built in French Guiana.

## Planet

### Imaging the world all day every day

Earth observation company Planet's co-founder Robbie Schingler spoke of his firm's continuous Earth imaging, day in day out.

Planet's satellite platform is called Dove and the firm operates a constellation in sun synchronous orbit. The Dove platform's dimensions are 10 x 10 x 30 centimetres and it has a mass of 4-5 kilogrammes. Its camera captures red green blue and near infrared imagery. The constellation provides data constantly so customers can examine an area and see how it has already changed, or not. Doves have been launched from the Japanese Experiment Module on the International Space Station with the cooperation of the Japan Aerospace Exploration Agency and NASA.

Schingler and his colleagues are ex-NASA scientists that started Planet in 2010. Referring to the historic availability of Earth observation imagery, Schingler told the audience: "We have for a long time only had a few organisations that knew what was going on [on Earth]."

Depending on the orbit, the Dove provides a resolution of 3-5 metres per pixel. Providing terabytes of data over time the information that arrives via the ground stations is ultimately available on a Cloud based service. One million images are sent by the Doves daily and they are colour corrected and aligned with maps automatically. Customers can interrogate the data using an application program interface.



### Making the Moon Village and Mars Journey Accessible and Affordable for All

Deciding what the private sector will do and what the government does is going to be important in making Moon and Mars accessible and affordable, the Wednesday 28 September, Global Networking Forum session, heard.

Proposed at the beginning of his appointment as Director-General of the European Space Agency (ESA), Professor Johann-Dietrich Woerner's Moon village is a community that seeks to explore the Earth's natural satellite. "Some people come together to form a community and they have diverse interests...but they choose to become a community," Woerner said.

For the Director-General, the Moon is an environment for science and testing technologies.

He referred to 3D printing as one technology. A developer of technology for ESA is OHB System and its management board member, Franz Merkle, stressed that, "we have to find the balance, what is publicly funded and when does the private companies take over."

Dr George Nield, Associate Administrator for Commercial Space Transportation at the Federal Aviation Administration (FAA), spoke of a virtual marketplace that could be created long before there is any activity on the Moon. The marketplace would allow people to offer goods and services for the exploration of the Moon and those seeking suppliers to enquire about who can supply what they need.



He talked about the enthusiastic response of US industry to Woerner's Moon village concept, and that: "The companies we work with encouraged us to see if we could help and make this happen. We need to be open to new ways of doing business. We should think bottom up rather than top down. What can industry bring too public, private partnerships." He added that in the USA they are now seeing more innovation and a greater readiness to take risks because of private enterprise taking on a new role.

Whether it is Moon or Mars, NASA's Deputy Administrator Dava Newman said that while, "there will be a few lucky astronauts at the beginning...we have to take everyone with us so they feel they can participate." In the short term Newman talked about the "citizen science" initiatives NASA was taking. Nield has spoken of a need for more than just astronauts and scientists. For settlements on the Moon and Mars there is going to be a need for miners for the resources to support outposts and other roles supporting normal daily life.

Europeans and one Chinese. They were isolated in their interplanetary spacecraft mock-up, faithfully following the phases of a real mission. Even communications with mission control were delayed to mimic the natural delays over the great distances on a real Mars flight. Rettberg reported that the microorganism levels at the end of that mission were no different too a private two-person household, for example.

While the volunteers did 100 experiments related to linked to the problems of long-term spaceflight, they could not fully mimic the bone loss problems that astronauts have in microgravity. Over time bone is lost in microgravity and Yi-Xian Qin, Professor of Biomedical Engineering and Director of the Orthopaedic Bioengineering Research Laboratory, told the session that bone loss was

usually around the lower spine, pelvis and legs. Qin saw a solution in mechanotransduction, which is the heavy loading of bones and skeletal muscle through rigorous exercise.

While exercise can improve bone and muscle and microorganisms and plants keep the astronauts healthy and occupied, Dr Nick Kanas, Professor Emeritus of the University of California, is concerned about the effect of, "seeing Earth as insignificant blue dot". He told the session that the International Space Station (ISS) should be used as a simulator to recreate this distant isolation. Astronauts spend a lot of time looking down on the Earth and talking to families while on the ISS. On the way to Mars the Earth will become small and family communication will have longer and longer delays making normal conversation impossible.



## 4 Subjects 180 Days CELSS Integration Experiment and Manned Deep Space Exploration

Micro-organisms, plants, mechanotransduction and a resistance to isolation will all be needed for living in deep space.

The Global Networking Forum session, 4 Subjects 180 Days CELSS Integration Experiment and Manned Deep Space Exploration, heard from Chinese, American and German scientists about what it will take to live beyond low Earth orbit.

Space Institute of Southern China Vice Dean, Li Yinghui, described the SpaceEnter, a facility that is being used to test technologies and crew cohesion for long range spaceflight. SpaceEnter is an analogue spacecraft able to support a crew of up to six with eight sections, each of which has a function. The SpaceEnter facility has an ecological life support system and a 180-day mission was carried out to test it and other factors for long duration missions.

The crew used Tai Chi and traditional Chinese medicine as well as growing wheat and potato. In Yinghui's opinion: "We think plants have a magical and unique role [in long duration spaceflight]."

Ecological, or bio-regenerative, life support systems need microorganisms to breakdown waste and facilitate plant growth. Petra Rettberg told the session that micro-organisms will be key to food production, life support and astronaut health in deep space. Rettberg is Team Leader of the Astrobiology-Group at the Institute of Aerospace Medicine in Germany's German Aerospace Center.

She spoke of the Mars500 simulated mission. It was a 520-day simulated Mars mission at the Institute of Biomedical Problems in Moscow with six volunteer crew made up of three Russians, two



## Aiming at a resilient and sustainable space security system

The aim of this GNF on space security was to have a holistic approach to this question, analyzing what is at stake from a system perspective, not just concentrating on the space segment which is too often the case. To that end, four reputed specialists took the floor to give their views about resilient space security, looking more specifically at:

– *The space segment.* Xavier Pasco (FRS, France) indicated that the US space surveillance network has served as a common facility leading to better collective management of the space resource, and is upgrading into a new capability to track up to 250 000 space objects. He insisted on the difficulty of proving and attributing an effect to an indisputable cause, whereas the challenge of confirming such an attribution was even bigger: technical data and political pressure/declaration being needed though interweaved.

– *The ground segment.* Peter Hays (Eisenhower Center for Space and Defense Studies, USA), after sketching out how space assets are central to a wide range of defence & security missions, summarized the desired attributes for a resilient ground infrastructure, namely but not only: receptive to enterprise-level governance and funding approaches from a variety of sources; shared, inter-operative, secure and redundant infrastructure; hardened; service-oriented architecture; agile and preplanned responses and work-arounds for outages, well-educated and trained workforce. The Air Force Space Command and Operationally Responsive Space Office Multi-Mission Satellite Operation Center was taken as an example.

– *The spectrum segment.* Attila Matas (ITU, Switzerland) explained how the objectives of the ITU, along with allocation of spectrum and allotment of frequencies and orbital



positions, are to harmonize and standardize telecommunications practices and eliminate harmful interference with those activities. The coordination provisions & interference were presented, insisting that there was no distinction between unintentional and harmful interference. Yet, in case of harmful interference, how ITU radio regulations can help? The issue of attribution (see above) is clearly at stake here also.

– *The cyberspace segment.* Brett Biddington (Space Industry Association of Australia) indicated that although satellites are vulnerable-subject to deception, denial, disabling or destruction, cyberattacks address the whole space system and are easier to carry since they can take advantage of security or hardening loopholes almost anywhere in the system. These weaknesses are the most difficult to bridge for and need a detailed risk mapping at all stages of conception, manufacturing and operations; a good measure of the pervasiveness and the extent of this issue.

– *Some policy and legal considerations* were also presented by Brett Biddington. As space has now become a critical infrastructure for the global economy, it needs to be looked at as a system with a combination of lenses (legal, policy, technology, entities-state/non-state-, entrepreneurs/agencies) addressing a range of differences which pertain to these angles of view. To be a player in the hierarchy of nations with respect to space., smaller nations should learn about their own dependencies and associated vulnerabilities, not leave the discussions to the spacefaring nations (representing 53 % of the world population), have a point of view backed by data, call out bad behavior, and lift the bar on the quality of the discussion which should be diverse and articulate.

This GNF was moderated by Serge Plattard (European Space Policy Institute-ESPI, Austria), and was Supported by the IAF Committee on Space Security, and sponsored by Mary Ann Liebert, Inc. publishers

When Hawking flew there were no problems.

Commercial spaceflight laws in the USA requires passengers to be fully informed of the risks so they fly at their own risk. This is deemed important to avoid potential litigation if a tourist were maimed or killed by an in-flight accident.

However, the ability of the informed consent rule to stand up in a court of law has not been tested and, like the impact of pre-existing conditions on passengers, the likely outcome is unknown.



## Space Medicine and Tourism Space Transportation

Space tourism operators will have to make decisions whether customers with medical conditions can fly because of the lack of historical data.

Federal Aviation Administration Aerospace Medical Institute Director, Dr Melchor Antuñano, told the Global Networking Forum's Space Medicine and Tourism Space Transportation

session that authorities have very little knowledge of people going into space with medical conditions. Passengers may not disclose pre-existing medical conditions that result in in-flight medical emergencies. Space tourists can expect to experience g forces from two to six

or seven g for tens of seconds, especially in the descent phase of sub-orbital flights. There have been tourists that have gone to the International Space Station for stays of up to 10-days and they have had surgery to correct medical conditions. But, these examples are very small in number.

Antuñano said: "We have very little knowledge of people with medical conditions going into space." He added that what needs to be decided is, what is the minimum, "right stuff," to enable someone to fly. What conditions could prevent people from flying, deformities, disease, infections? What could histories of self-imposed stress, poor fitness, drug abuse, alcoholism, mean for flight eligibility? Antuñano also posed the question, would operators allow a terminally ill person to fly?

He gave an example of how Professor Stephen Hawking had gone on a zero g flight and that preparation for it had included doctors taking an earlier flight with the equipment needed to treat any medical emergency of the professor's and using it to practice on an able bodied volunteer.



## Rosetta - Controlled Impact on Comet 67P Churyumov Gerasimenko

Rosetta was the first mission in history to rendezvous with a comet, accompany it around the Sun and deploy a lander to the comet's surface. Launched in March 2004 by an Ariane 5 from Europe's spaceport at French Guiana, the spacecraft, an orbiter, and its lander, Philae, travelled nearly 8 billion kilometres and spent 31 months in deep-space hibernation at one point. Waking up in January 2014, Rosetta arrived at the comet in August of that year. It would deploy Philae in the November.

Philae took the first images of a comet's surface, but, the lander's harpoons that would have secured it to the surface on landing in the comet's micro-gravity environment failed. Philae bounced away and eventually landed in a location that made it difficult for its solar panels to receive sunlight. Philae's battery lasted three days and then the lander went into hibernation, heard only once more in June and July last year when its proximity to the sun allowed the solar panels to receive enough energy.

Speaking in hall eight, Pascale Ehrenfreund, chair of the DLR Executive Board, said of Rosetta: "For the first time we found organic molecules on a cometary surface. Rosetta and Philae have shown us how we can expand our horizons with space research."

A collective gasp and applause from the International Astronautical Congress audience greeted the end of the Rosetta mission at 06.19am Guadalajara, Mexico time, when the signal from the spacecraft with the same name stopped as it touched down on the surface of the comet 67P/Churyumov-Gerasimenko.

European Space Agency mission, ESA Director-General Johann-Dietrich Woerner spoke at the Global Networking Forum – Rosetta – Controlled Impact on Comet 67P/Churyumov Gerasimenko session in hall eight before the touchdown and recalled Rosetta's Ariane 5 launch: "It was a perfect day for launch in 2004."

In ESA's statement about the mission's end, Woerner said: "Rosetta has entered the history books once again. Today we celebrate the success of a game-changing mission, one that has surpassed all our dreams and expectations, and one that continues ESA's legacy of 'firsts' at comets."

The orbiter carried out its final manoeuvre at 20:50 GMT (22:50 CEST) on 29 September, setting it on a collision course from an altitude of about 19 kilometres. Rosetta was expected to impact in a region of the comet's surface ESA calls Ma'at. Italian Space Agency President Roberto Battison said: "Now the two parts of this mission will truly become part of our universe."

Speaking from ESA's European Space Operation Centre (ESOC), Rosetta Project Scientist, Matt Taylor, said: "We have decades of work to do with this data, the science will continue. This stuff [water/organics]

could be delivered to the Earth by comets. [Rosetta] has made us change our view of what comets are and where they came from."

Also speaking from ESOC, Rosetta mission manager, Patrick Martin, said: "The Rosetta mission was inspiring to many, was historic, pioneering."

Rosetta was named after the rock stele found in 1799 in Memphis, Egypt that had a decree by Pharaoh Ptolemy V on it in ancient Egyptian hieroglyphs and Greek, enabling the translation of Egypt's hieroglyphs.

## China Manned Space Programme and Opportunity for Cooperation

The China Manned Space Programme is developing a plan to cooperate with United Nations member states and does not rule out foreign spacecraft docking with its planned space station. China Manned Space Agency's China Manned Space Programme's Deputy Chief Designer, Zhonggui Wang, told the Global Networking Forum – China Manned Space Programme and Opportunity for Cooperation session that the station would be operational around 2022. Construction will start in 2018.

The science conducted on the station would be varied and include, life sciences, fluid physics, combustion, materials, and fundamental physics. During the presentation, which was given verbally in Chinese, the slides were in English and showed that China wants to cooperate on astronaut selection, training, and flights for using their station. It will have a crew of three and each mission will be six months long. Roscosmos and the European Space Agency were identified in the presentation.

Earlier this year, China signed a framework agreement with the United Nations Office of Outer Space Affairs for station use with member states. Through a translator Wang said that his country was now developing the plan for that member state cooperation.

Before the space station, the next manned mission for China is Shenzhou 11 that will launch in October. Its two male crew will dock with the second space laboratory, Tiangong-2, for 30 days of experiments. Tiangong-2 was launched in September. The space labs are being used to prove technologies for cargo transportation, crew life support, propellant resupply, and ground based mission support. The science the crew will undertake on Tiangong-2 will include, a "space cold atomic clock," an interferometric imaging radar altimeter and the life cycle of plants in microgravity.

China's cargo spacecraft, Tianzhou, will see its first launch before June 2017. It will be launched by China's new CZ-7 rocket, which made its maiden flight in June this year from the new Wenchang space launch site. The CZ-7 can lift 13.7 tonnes into low Earth orbit. Tianzhou-1 will carry out propellant resupply when it reaches Tiangong-2.



# Educator's Professional Development Workshop and Student Outreach Day



The Space Education Outreach Committee (SEOC) and the International Space Education Board (ISEB) collaborated to sponsor the Educator Professional Development Workshop, which was held during the 67<sup>th</sup> International Astronautical Congress on Sunday, September 25, 2016 at the Expo Guadalajara. The theme of the workshop was, "Classroom Education for the 21<sup>st</sup> Century." Over 50 local educators participated. Ian Christie, Curriculum Developer, Victorian Space Science Education Centre (VSSEC), Melbourne, Australia served as the facilitator. He provided insight into techniques, which could be used in the classroom with confidence that there would be good science to show these techniques have a significant effect on student learning. This was done by building on the work of Mid Continent Research in Education and Learning, Denver, Colorado. He also focused on "Powerful Science Activities with Simple Equipment." Participants took part in activities, which VSSEC used in its outreach program to teach fundamental science without needing expensive or elaborate tools and equipment. The program has a built in requirement for teachers to pass on their knowledge to each other to ensure

the skills are spread widely. The workshop also used the "Tickle My Droid Application," where Sphero Robotic Droids and the Tickle iPad were used to lead students into 21<sup>st</sup> Century skills in computer coding and robotics. The educators were taught how to use "Scratch" to teach students. "Scratch" is a new programming language that makes it easy to create interactive stories, games, and animations and then share the creations with others on the web. As another collaborative effort, members of the ISEB, along with ISEB students and members of the SEOC taught "Scratch" to nearly 200 local students during the "Student Outreach Day," which was held on September 30<sup>th</sup> in the International Student Zone at the Expo Guadalajara.

The following links contain photos of student outreach activities:

[https://www.dropbox.com/sh/c6zc5c4bdw2kije/AAA0dSouvF1mS5tptfixT\\_Oa?dl=0](https://www.dropbox.com/sh/c6zc5c4bdw2kije/AAA0dSouvF1mS5tptfixT_Oa?dl=0)

[https://www.dropbox.com/sh/ycesimv3ouv1idpv/AACqZVRacuxgXRn\\_eKaU1tbCa?dl=0](https://www.dropbox.com/sh/ycesimv3ouv1idpv/AACqZVRacuxgXRn_eKaU1tbCa?dl=0)



# IPMC YP Workshop

Young Professionals: shaping the future of the space sector

In late September, 25 young professionals working in the aerospace sector took part in IAC's IPMC YP workshop, exchanging ideas and proposals to help shape the next generation workforce. The workshop took place just ahead of the 2016 International Astronautical Congress (IAC), in Guadalajara, Mexico.

The Young Professional (YP) Workshop is an annual event commissioned by the International Project/ Programme Management Committee (IPMC). By gathering information from YPs, the IPMC member organisations hope to better understand, empower and develop the next generation workforce.

## International collaboration

Twenty-five YPs attended the workshop from 11 countries, representing 15 public research organisations, NGOs, industries and academic institutions. They worked intensely in the months prior to the event through online collaboration, meeting mostly by Skype, conducting in-depth interviews and surveys, and reviewing literature studies.

This year's topics and a high level summary of the recommendations were;

- Low-Cost Agile High Performance Space Missions
  - » Agile Scrum Methodology combined with Concurrent Engineering throughout projects
  - » Digital Transformation, with specific recommendation on manufacturing and serial production projects
  - » Standardisation by means of internationally approved impartial organisations (based on cubesat case study)
  - » Recommendations for cost controlling policies for space projects

- Knowledge Management in the Aerospace Sector
  - » Holistic approach
  - » Make knowledge available in multiple formats
  - » Promote documentation to a central task of knowledge holders
  - » KM experts to be designated
- 5-year IPMC YP workshop: Practice and Aspirations
  - » Try to provide a timing scheme, like a 3-year plan.
  - » Channel into areas where organisations have already expressed interest
  - » Identify a point of contact to enable those working on implementation to reach out for guidance and clarification.

The findings and recommendations of each topic group were presented during a one-hour Q&A session to IPMC members and other interested members of the audience.

## Putting ideas into practice

In collaboration with IPMC member organisations, efforts are now underway to implement the recommendations of the workshop. There will be a progress update on the implementation at the IAF Spring meeting in 2017.

The final report containing the main results, conclusions and recommendations will be published on the IAF website before the end of the year.

## More information

If you would like to know more about this event, please write Birgit Hartman or Maarten Adriaensen at [ipmc.yp.workshop@gmail.com](mailto:ipmc.yp.workshop@gmail.com)



# IAF IDEA "3G"



INTERNATIONAL PLATFORM FOR DIVERSITY AND EQUALITY IN ASTRONAUTICS  
3G GEOGRAPHY • GENERATION • GENDER



## Nothing succeeds like diversity

Diverse workforces both in gender and ethnicity lead to more successful enterprises, the IDEA luncheon heard on Wednesday 28 September.

The International platform for Diversity and Equality in Astronautics, IDEA, luncheon heard keynote speeches on, geographical diversity from European Space Agency Director General Johann-Dietrich Woerner, generation diversity from NASA Deputy Administrator Dava Newman and gender diversity from Lockheed Martin Space Systems Company Strategy and Business Development Vice President, Kay Sears.

International Astronautical Federation (IAF) President-elect Jean-Yves Le Gall gave the opening speech and spoke of his principles of three G (3G) diversity within the Federation and the space sector, geography, gender and generation. Starting with the IAC 2016, the 3G diversity focus will be part of the IAF's Global Innovation Agenda 2016 – 2019. This calls for the creation of an IAF Platform which will allow the Federation to take a leading role in promoting and advancing diversity and equality principles in the global space community.

Sears told the luncheon the 3G concept was "good for business," and that a study by management consultancy McKinsey & Company found that gender diverse companies were 15% more likely to outperform the industry average and ethnically diverse firms were 35% more likely.

While Newman's speech was about generation diversity, she identified an issue at NASA where it would take until 2050 before there was parity between men and women scientists. This is because the rate of increase in women scientists was only 1%. About 28% of NASA's scientists are women and 23%

are engineers. Newman pointed out that by 2050, "we will be on Mars before we reach parity." Sears cited issues with, "social norms," about girls and women and told the audience that women, "don't own their own future," and there was no emphasis in society on telling the stories of successful women.

On generations, Newman said that telling children they had to be the best in science and mathematics was intimidating. The conversation had to be changed to an inspirational one about helping to solve society's problems. NASA research had concluded that for young people to make their career choice, they have to see themselves as that engineer or scientist, they need to have a sense of belonging to the community associated with that career, and that community needs to act in an inclusive way.

Woerner's geographical diversity speech talked about people with different geographical backgrounds having different ways of solving problems and that this was a benefit. The last speech was from Space Generation Advisory Council (SGAC) Executive Director Minoo Rathnasabapathy. The SGAC now has 4,000 members across 110 countries. She spoke of the work those members do in their spare time to make the SGAC's Space Generation Congress happen.

Rathnasabapathy said: "We celebrated our 15th Space Generation Congress, a landmark event for SGAC," adding that the congress had 151 delegates from 32 countries. She also asked for applause for five SGAC members whose work had been outstanding. They were from Canada, Israel, Germany, France, India and Mauritius. At the IDEA luncheon, IAF president-elect Le Gall said that the diversity "agenda will ensure the sustainable development of our federation."



# International Space Education Board (ISEB) Student Program

The ISEB Student Program was held in Guadalajara, Mexico from 25-30 September 2016, as part of the International Astronautical Congress (IAC). The Student Program 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 Program. Approximately 75 ISEB sponsored students participated. Students had the opportunity to present technical papers and posters throughout the week, as well as hear from leaders in the space world and network with colleagues from around the globe. The Student Program ended with an Outreach Day on Friday, September 30, where approximately 200 local students came to the International Student Zone and participated in Science, Technology, Engineering, and Mathematics (STEM) activities that were educational and fun. The ISEB also worked with the Space Education Outreach Committee to

co-sponsor the Educator Professional Development (EPD) Workshop. Both activities were intricate parts of the IAC. The EPD workshop was held on September 25 and VSSEC led the training for over 50 local educators, with support from ISEB sponsored students and staff. The sessions gave teachers new skills and information to enable them to better prepare their students to live and work in the 21<sup>st</sup> Century. Scratch, a new programming language that makes it easy to create interactive stories, games, and animations and share the creations with others on the web was taught in the Educator Professional Development Workshop to teachers, as well as to local students on Friday during the Outreach Day. These collaborative efforts promoted positive interactions that left a positive imprint on the local community.



# IAC Hosts Summit

Variety is the key to success

A more diverse event, bigger youth involvement and greater accessibility through social media, were some of the views heard during the Hosts Summit of the International Astronautical Congress 2016, held in Guadalajara, Mexico.

With five sessions covering, youth, new media, new space, winning and successful legacies, youthfulness was a thread running through all. Corporate partners wanted young professionals involved in Congress', Peter Von Kampen from the Bremen IAC 2018 local organising committee, told the fifth session, How to win a bid. The Hosts Summit is where past and present IAC holders and competitors for future Congresses meet.

Winning, and how to measure a successful outcome, involves six or seven constituencies, according to the Chief Executive of the forthcoming Adelaide IAC in 2017, Brett Biddington. His constituencies include not only industry and young professionals, but also the downstream users of space systems.

Biddington, and all the other Hosts Summit participants, referred to the complexity of a Congress. Von Kampen, whose city, Bremen, held an IAC in 2003, stressed the importance of having a theme - to give direction to that complexity. Biddington echoed this, referring to the Adelaide Congress' strapline of security, innovation and imagination. For Biddington, imagination referred to how Australia's youth could see the future and innovation, what the country's space industry does today - all 10,000 of the people working for it. Security is what space has contributed to Australia already.

What has come before was also important for Dr John Horack, IAF Vice President Technical Activities

and IAC Evolution, and Mary Lassiter Snitch, IAF Vice President Global Membership Development and Global Conferences. During Horack's speech, opening the Hosts Summit, he spoke of how some people in the room were children of the Apollo program, or Skylab, or Space Shuttle and teenagers today were the generation of the International Space Station. Those long past programs inspired the young back then and now these people were sat together at the Summit. For Lassiter Snitch, talking during the Summit's The IAC: A platform for the New Space Community? session, those programs of the 1960s, 1970s and 1990s, and others, had contributed to a wealth of knowledge that could be drawn on by the more recent space companies.

Referred to as New Space, this community of recent companies offer capabilities at fixed-cost contracts, unlike NASA's traditional funding arrangements of meeting all of the contractors' costs. The likes of Space Exploration Technologies and Blue Origin would have been able to access United States government owned intellectual property developed under past rocket and spacecraft development programs; undertaken by the established aerospace firms. Ariane Cornell, a panel member of the New Space community platform session and part of Blue Origin's Business Development and Strategy team, agreed with Lassiter Snitch's comment.

The culmination of decades of Congresses was that it had become the best event for networking in the world's space industry, according to Cornell. With a typical attendance of more than 4,000 people, few other events can compete. The 2016 IAC was the first Congress that Blue Origin had a team attending. Only Cornell had attended on behalf of Blue Origin at her previous IAC. For Blue Origin, IAC is about getting to, "know the wider space community," Cornell said.

That networking is facilitated through five, "modes of interaction," as Horack put it. They are, the IAC's technical sessions, the exhibit, plenary sessions,

cocktail events and the Global Networking Forum. One mode of interaction should be changed, Biddington said during the How to win a bid session. He suggested reducing the range of technical topics, citing the number as a cause for event complexity. His idea is to have fewer, but, “still diverse,” sessions. Lassiter-Snitch said that with so many sessions some did have to be missed.

Another more outward perspective on networking was how organising an IAC would lead to greater cooperation between the arms of a government, a country’s industry, academia and other stakeholders, such as local communities; which could also benefit. The IAC 2016 local organising committee Executive Director, Enrique Pacheco, described how IAC 2016 needed a social impact. Communities in Chiapas and Jalisco, “were benefitting”, he said, from the IAC’s presence in Mexico.

Photos and comments about the Host Summit were published on social media during the event itself. The interest of the world’s youth, including young professionals, in social media is well known. The importance of social media for increasing involvement, and allowing people to learn about a sessions’ key points, was spelled out during the Keynote: The IAC and the New Media Age session. Otto Koudelka, IAF Vice President, Communications and Publications gave the keynote by video and said that IAF was, “very active on social media”.

Facebook is the IAF’s most important social media platform which has achieved more than 10,000 page likes. IAF crossed 10,000 page likes in June. Facebook is used for announcements, as is Twitter. IAF has more than 4,000 followers on Twitter and on

Youtube. IAF’s Youtube channel now has 695 videos including short videos called Capsules, which are IAF members introducing themselves. IAF also has Instagram and Flickr accounts. Koudelka said that future plans include sharing IAF members’ news through social media.

Young peoples’ expertise on social media platforms could be a role they could play on the IAF’s bureau. In the Summit’s session one The IAC: An inspiration for the Young Generation, IAF Vice President for Education and Workforce Development, Professor Chris Welch said that in the past there had been proposals for young professionals to be on the IAF’s bureau. He saw a strong role for young people as in-coming IAF president, Jean-Yves Le Gall, had an agenda he summed up as the three Gees, geography, generation and gender.

In the same session, Space Generation Advisory Council Executive Director, Minoo Rathnasabapathy, told the Summit that the next generation wanted to be engaged and that the IAC was a great way to learn about the industry. “Young people don’t want to be spectators, they want to be participants,” Rathnasabapathy said.

Illustrating the long term nature of space projects and the need to nurture talent through events such as IAC, Welch pointed to the fact that a project he had worked on as a young professional was about a mission to land a probe on a comet. Decades later, that mission was Rosetta which ended during the IAC week in Guadalajara with the spacecraft with the same name joining its lander sibling, Philae, and impacting the comet’s surface for science.



## 7<sup>th</sup> International Meeting for Members of Parliaments (MOP)

The International Meeting for Members of Parliaments (MoP) is an annual event held in conjunction with the International Astronautical Congress organised by the IAF. This event brings together a selected number of Members of Parliaments from around the world interested in space matters. The MoP event serves as a forum of exchange amongst Members of Parliaments and high level experts from government, industry and academia. The 7<sup>th</sup> International Meeting for Members of Parliaments (MOP) of the International Astronautical Federation’s (IAF) was held on 25 September 2016 alongside the 67<sup>th</sup> IAC in Guadalajara, Mexico. The topic chosen by the Mexican Parliament was ‘Space and the Information Society-Connecting the World via Space - Policies, Technologies and Applications’. The event brought together high level speakers

from the space community to provide their expert views.

The Members of the Mexican Parliament Bañales Orozco and Mirza Flores Gomes welcomed the participants. The IAF President Kiyoshi Higuchi, in his opening speech stressed the importance on parliaments in decision and policy making for the future of space activities. The ESA Director General, Jan Wörner, provided an overview on the shift of paradigms the space sector is facing and explained his vision on Space 4.0 as a response to global challenges. The second keynote speaker, Jean-Yves Le Gall, CNES President focused on the success of COP 21 in Paris, underlining the contribution of space technologies and applications in monitoring and support in mitigating against climate change. The third



keynote speaker, Simonetta Di Pippo, Director of United Nations Committee on Outer Space Affairs (UNOOSA), addressed the role of space in supporting the sustainable development goals (SDGs) in developing countries.

The event included two thematic sessions on: 1) disaster management and 2) space and the information society, and each was followed by a discussion panel. In the disaster management session, the ESA Director of Earth observation programmes, provided an overview on ESA activities in the field and the role of the International Charter on Space and Major Disasters. The second speaker, Luc St. Pierre presented the UNOOSA activities and the Spider program. Deliberations followed between the speakers and the Members of Parliament with focus on open access to data. The second panel on space and the information society included the presentation of Attila Matas who provided an overview of the role of ITU in ensuring the promotion of an information society and the importance of safeguarding frequencies. The second presentation from Christina Giannopapa from ESA focused on the role of space

technologies and applications in a number of sectorial policies (e.g. transport, energy, regional development, security, agriculture, fisheries). The deliberation focused on raising awareness on the role of decision and policy makers about the role of space for responding to global challenges.

At the open discussion amongst the parliamentarians, Mexico called for the effective implementation of these mechanisms and for the promotion of an open data policy. Romania and Poland stressed the need of monitoring and analysis of data against illegal activities. South Africa highlighted the availability of data to countries in need of solutions for development issues, while Austria drew the attention to data safety. Kai-Uwe Schrogl, ESA's Chief Strategy Officer, who moderated the event, concluded the session by inviting the politicians and decisions-makers to raise the awareness in their countries for the potential of space applications. Only through their efforts can sustainable development by broader use of space applications and technologies be supported. The next event will take place alongside IAC2017 in Adelaide, Australia.



# UN/IAF Workshop

Summary of the United Nations / International Astronautical Federation Workshop on Space Technology for Socio-Economic Benefits: "Integrated Space Technologies and Applications for a Better Society".

Guadalajara, Mexico, 23-25 September 2016 in conjunction with the 67<sup>th</sup> International Astronautical Congress.



## Opening session

The Workshop was opened with welcoming remarks from the Director General of the Mexican Space Agency, the President of the International Astronautical Federation, the representative of ESA and the Director of the Office for Outer Space Affairs. The speakers noted the achievements of the United Nations/IAF series of workshops since 1991 in fostering space technology capacity-building and bringing representatives of emerging space countries to the annual International Astronautical Congress.

In his keynote address, the representative of the Instituto Politécnico Nacional of Mexico reviewed the role of space activities as a factor that enabled solutions addressing societal challenges. In addressing the importance of space capacity-building he referred to the example of the development of remote-sensing payloads for small satellites. Mexico was one of many countries that had made small satellite development activities a priority of their space technology capacity-building road maps.

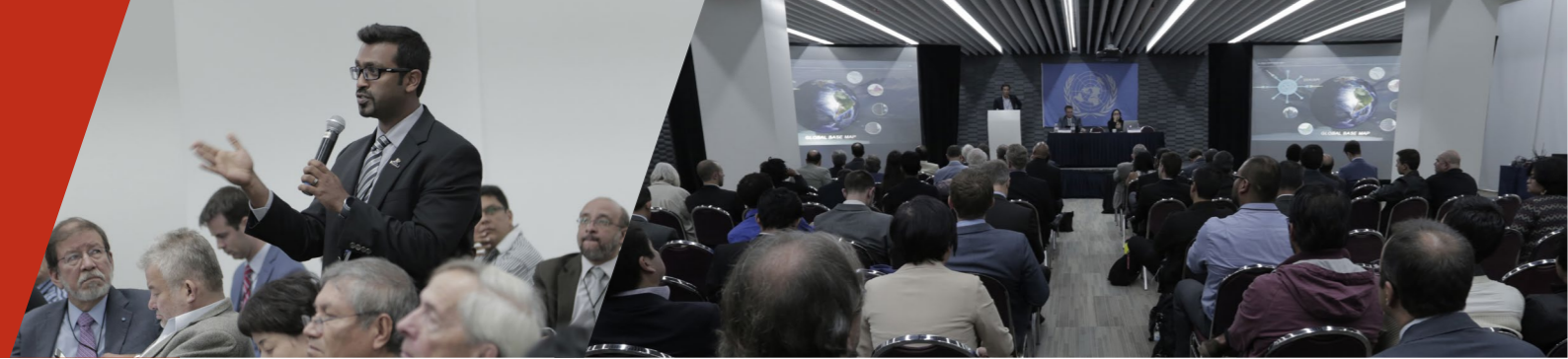
The Director of the Office for Outer Space Affairs outlined how space-based solutions were used in support of addressing global challenges and how the Office was contributing to those efforts by building capacity in the use of space science, technology and its applications. She stressed the important link of the Workshop to the Sustainable Development Goals of the 2030 Agenda and informed the Workshop about the status of preparations for UNISPACE+50.

Following the two keynote addresses, a presentation reviewed the 25-year history of United Nations/IAF workshops, their origins, the diverse range of Workshop themes over the years and the achievements and contributions to space capacity-building facilitated by the Workshop series.

## First thematic session: space and sustainable development

The speakers in the introductory session discussed the importance of space activities for achieving sustainable development. A presentation reviewed the status of the work of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators and its Working Group on Geospatial Information to define indicators for the Sustainable Development Goals. It was stressed that dynamic data (varying over time and/or





space), including geospatial information, were fundamental to define indicators in support of making better decisions and policy. The presentation also showed how Mexico was using geospatial information in its national implementation framework of the 2030 Agenda.

The representatives of ESA, the German Aerospace Centre and the National Aeronautics and Space Administration (NASA) of the United States reported on their activities in support of implementing the 2030 Agenda. It was noted that space technology and its applications could contribute to all 17 Sustainable Development Goals.

A presentation by the European Space Policy Institute examined how development actors, including non-governmental organizations, could benefit from space applications, and made recommendations for better linkages between the space community and the development community. Other presentations in that thematic session considered how enhanced space cooperation, the implementation of a dedicated space policy to strengthen the scientific and technological development of a country, and the participation of space industry could help countries, developing countries in particular, to better utilize space in support of achieving sustainable development.

### Second thematic session: space technology capacity-building

The second thematic session featured various presentations on the role of space capacity-building to strengthen capabilities of countries to serve their society. Many international programmes offered opportunities for aspiring space professionals from developing countries.

In his presentation, the Secretary General of the Regional Centre for Space Science and Technology Education for Latin America and the Caribbean reported on the status of the centre. The Regional Centre is one of six regional centres affiliated to the United Nations established

under the leadership of the Programme on Space Applications of the Office for Outer Space Affairs.

Representatives of the Kyushu Institute of Technology, the University of Colorado Boulder and the University Space Engineering Consortium (UNISEC) — Global secretariat presented capacity-building initiatives for space technology development, such as fellowship programmes and academic and cooperation programmes for collaboration in small satellite development. A presentation by the Mexican Space Agency discussed the status of space capacity-building in Mexico.

The session concluded with two presentations on capacity-building in human space technology under the Human Space Technology Initiative of the Office for Outer Space Affairs: on utilization opportunities on board the Chinese manned space station, and on spaceflight opportunities using Sierra Nevada Corporation's Dream Chaser spacecraft in the framework of a future United Nations Dream Chaser mission.

### Third thematic session: disaster management and early warning

Presentations in the third thematic session focused on the applications of space technology for disaster management and early warning. The session began with a review of the accomplishments and activities of the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) which celebrated its tenth anniversary in 2016. A representative of the Dominican Republic reported on the impact of a technical advisory mission conducted by the Office for Outer Space Affairs in the framework of UN-SPIDER. As a result of that technical advisory mission, a national integrated information system and geospatial information team was established in the Dominican Republic to coordinate the country's disaster management activities, to respond to emergency situations and support capacity-building. Another example of a UN-SPIDER intervention is the regional

coordination for transboundary hazards under the Strengthening Early Warning Systems for Droughts (SEWS-D) project, presented by the Mexican Space Agency.

How space technology can assist with disaster management and early warning was discussed in a presentation by a representative of NASA on the development of an innovative global navigation satellite system (GNSS)-enhanced tsunami early warning system based on the measurement of disturbances in the ionosphere, which can be used to detect tsunami events, and on the use of constellations of small satellites for disaster management of remote areas.

The useful applications of geospatial data were highlighted in presentations on FATMAP, a crowd-sourced mapping initiative built on advanced analysis and data compression software allowing for the distribution of remote-sensing and geographic information system (GIS) information to mobile platforms

### Fourth thematic session: space for global health and education

Space technology and its applications can provide many solutions for global health and education. The representative of the World Health Organization presented an overview of the contributions of space science and technology for advancing the health-related Sustainable Development Goals. He concluded that much had been achieved due to advances in technology but that there remained a need to strengthen the integration of technology and health systems, as well as implementing supporting policies.

The activities of NASA in the field of space education, aiming to challenge students to become future innovators, were presented by the Associate Administrator for Education of NASA. The activities address all educational levels, from elementary to graduate education. Specific programme elements supported the empowerment of young girls and women.

The session concluded with a presentation by a representative of the Mexican Space Agency on Mexico's space life science activities. Several Mexican institutions and universities are involved in those activities, with efforts coordinated by the Mexican Space Agency.

### Fifth thematic session: space solutions for managing growing cities and populations

The presentations in the fifth thematic session considered the use of space technology and geospatial data for managing the needs of growing cities and populations, which are also addressed through several of the Sustainable Development Goals.

In her presentation on creating a resilient city using space data, the senior technology advisor to the Mayor of the City of Los Angeles presented an overview of the wide range of space-related projects carried out by the city, focusing on the use of geospatial data to establish policies for traffic management, mitigate traffic accidents, provide earthquake early warning services and contribute to the city's "comprehensive homeless strategy". A federal crowdsourcing and citizen science toolkit had been developed which enabled citizens to gather and submit data and information in support of city projects. Some projects had also developed into international projects, such as the "datanauts" project for the improvement of clean water delivery in Africa using crowd-sourced and satellite data. As shown by the experience of the City of Los Angeles, releasing and using open data empowered people to make better decisions.

A representative of the Beijing-based commercial satellite operator Twenty First Century Aerospace Technology explained how the company used satellite remote-sensing technology to manage fast urbanization in China. The TripleSat constellation of satellites provided sub-meter resolution geospatial data in support of a wide range of applications for fast urbanization in developing countries, supporting infrastructure development projects, detecting illegal activities in urban areas such as illegal dumping of rubbish, and monitoring and managing the environment and urban land use, as demonstrated by examples of operational applications developed for the City of Beijing.

Providing food security to a growing worldwide population was one of the challenges of



the coming decades and would require new technologies and solutions such as those provided by precision agriculture. A representative of the Mexican Space Agency presented how geospatial data could be used to improve crop management and land and soil use. The presentation reviewed the goals and benefits of precision agriculture and the activities carried out by the Mexican Space Agency to implement operational precision agriculture applications.

### Sixth thematic session: environment and biodiversity

The sixth thematic session addressed the use of space technology for monitoring and managing environment and biodiversity. The Secretariat Director of the Group on Earth Observations (GEO) presented the GEO vision, that is, to realize a future wherein decisions and actions, for the benefit of humankind, are informed by coordinated, comprehensive and sustained Earth observations and information, and presented the status of the work of GEO as it entered its second decade of existence. To achieve that vision, GEO was promoting principles for sharing open data. The GEO Biodiversity Observation Network had been established to support the Convention on Biological Diversity and was defining essential biodiversity variables to help ensure that Earth observation systems would be able to provide essential data to support implementation of that Convention.

The representative of the National Institute for Environmental Studies of Japan reported on the United Nations/Kenya Conference on Space Technology Applications for Wildlife Management and Protecting Biodiversity, held from 27 to 30 June at the United Nations Environment Programme headquarters in Nairobi. The conference had brought together representatives of the space community with wildlife experts from governmental and non-governmental organizations to review the status of space technology applications for biodiversity and wildlife management.

Other presentations described the International Partnership Space Programme between Mexico and the United Kingdom to utilize Earth observation products to address environmental problems in the Bacalar area, the status of and plans for the China-Brazil Earth Resources Satellite programme and a crowdsourcing-based architecture for monitoring water

basins, water pollution and illegal deforestation in Guatemala.

### Seventh thematic session: connectivity for reducing social divide

Satellite communications have contributed to globalization and reducing the social divide. The representative of ITU reported on the outcome of the Global Conference on Space and the Information Society, held at ITU headquarters in Geneva on 6 and 7 June 2016. The Conference participants discussed the decisions of the World Radiocommunication Conference 2015, the contributions of satellite communications to the Sustainable Development Goals, the space economy and its links to the information economy, space services and security, and big data and information society. Conference participants concluded that further harmonization and the removal of barriers created by national policies and regulations were needed, that free, full and open data policies were essential, that there were growing concerns about the privacy and protection of personal data and that benefits could be gained from integrated space applications.

The regulatory aspects of small satellite activities and space technology development at the National Autonomous University of Mexico were the focus of two presentations by representatives of the University and the Federal Telecommunications Institute of Mexico.

The representative of the University of Vigo, Spain, made a presentation on the status of the Humanitarian Satellite Constellation (HumSat) programme, which had been validated by data provided by two satellites. The in-orbit results had led to the development of HumSat 2.0, which was in the final design phase and would be demonstrated in orbit in the next two years to move the system from demonstration to the operational stage.

The coordination of the Mexico Conectado project and its contributions to reducing the social divide in Mexico were presented by a representative of



round of the KiboCube programme for deployment from the International Space Station in 2017. The second round of selection for a satellite deployment in 2018 had been opened.

### Panel discussion and round table

A panel discussion was held at the end of the second day of the Workshop, and a round table was held at the end of the Workshop, on its third day.

#### 1. Panel discussion on building capacity for space science, technology and its applications to contribute to economic, social and environmental sustainable development

The panel discussion was moderated by a representative of the National Autonomous University of Mexico with panellists from the Regional Centre for Space Science and Technology Education for Latin America and the Caribbean, the Kyushu Institute of Technology, the Mexican Space Agency, Embraer of Brazil and the Office for Outer Space Affairs. In their first discussion round, the panellists reflected on their individual experience with space capacity-building and identified challenges and opportunities. They agreed that a policy supporting investment in space technology capacity-building was important to ensure the availability of well-trained and qualified space technology and application experts needed in a country. The role of universities for human resource development was noted. Instilling a sense of self-confidence in engineers was also identified as important for capacity-building. International collaboration, in form of exchanges and fellowship programmes, could strengthen capacity-building programmes.

The panellists stressed the importance of hands-on education and training, giving trainees exposure to actual satellite development activities ranging from development, assembling, testing and launch to operation. Ensuring the continuity and sustainability of programmes and projects

the University of Guadalajara. From 2012 to 2016, the project had helped to increase the access to and use of broadband Internet by 157.1 per cent and Mexico had improved its accessibility and connectivity and network readiness as measured by the World Economic Forum.

The session concluded with a presentation on the role of the University Corporation for Internet Development, a non-profit consortium of Mexican universities that manages Mexico's national research and education network and was established in 1999 to provide high-bandwidth connectivity to university and research institutions in Mexico.

### Eighth thematic session: special presentations on the KiboCube programme

In 2015, the Office for Outer Space Affairs and the Japan Aerospace Exploration Agency (JAXA) launched the United Nations/Japan Cooperation Programme on CubeSat Deployment (KiboCube) from the International Space Station Japanese Experiment Module (Kibo). The programme makes it possible for developing countries to deploy one-unit CubeSat satellites. A representative and astronaut of JAXA discussed how the programme was supporting space capacity-building in developing countries. That was followed by a presentation by the representative of the University of Nairobi, whose first Kenyan university nanosatellite precursor flight (1KUNS) project had been selected in the first selection



should be considered right from the start when defining activities for space capacity-building, for example by means of a supporting adequate long-term policy. A single failure should not lead to the immediate demise of an activity. Universities had a key role in ensuring continuity.

## 2. Round table on linking the Workshop to the fiftieth anniversary of the United Nations Conference on the Exploration and Peaceful Uses of Outer Space

The round table was moderated by the Director of the Office for Outer Space Affairs, with a high-level panel of space experts, composed of three heads of space agencies — ESA, the German Aerospace Centre and the Mexican Space Agency — as well as a JAXA astronaut and the current Chair of the Committee on the Peaceful Uses of Outer Space. Round-table participants discussed how space technology and its applications and relevant policies could contribute to creating a better society.

The discussions linked the Workshop's objectives to the preparations for UNISPACE+50, an event that would act as a catalyst for optimizing the future use of space-based solutions to contribute to addressing the world's challenges. UNISPACE+50, to be held in 2018, would bring together States Members of the United Nations to reach consensus on a global space agenda for the next two decades. The round-table discussion focused on space solutions for sustainable development and on thematic priority 7 of UNISPACE+50: "Capacity-building for the twenty-first century" (see A/71/20, paras. 296 and 297). 55. Following the introductory remarks by the moderator, the panellists were asked how their organizations, as stakeholders in that process, would contribute in concrete terms to the goals of UNISPACE+50. All panellists referred to the

contributions their organizations were already making in support of space capacity-building and in providing access to space technology and applications, including for developing countries, and noted the important governing role of the Committee on the Peaceful Uses of Outer Space and UNISPACE+50 and its thematic priorities as principal frameworks in that process. The thematic priorities needed to be further developed, in particular through the activities of the high-level forum on space as a driver for socioeconomic sustainable development held in 2016 and 2017. It was noted that UNISPACE+50 might also strengthen space governance and contribute to increasing the membership of the Committee on the Peaceful Uses of Outer Space, given that several countries with space activities were not yet represented in the Committee.

The importance of international cooperation, including at the regional level, was stressed in the discussion. UNISPACE+50 could strengthen the role of the Office for Outer Space Affairs in supporting space cooperation efforts and coordinating space-related activities with other United Nations organizations.

### Poster session

Following the first thematic session on the first day of the Workshop, a poster session was held allowing participants to view the 19 posters displayed throughout the duration of the Workshop and discuss their content with the authors. The posters addressed a wide range of examples of space science, technology and applications linked to the theme of the Workshop.



# THE 1<sup>ST</sup> INTERNATIONAL SPACE FORUM AT MINISTERIAL LEVEL and the adoption of the Trento Space Statement

42 governmental delegations, composed by Ministers, Ambassadors, Heads of space agencies, representatives of International Intergovernmental Organizations and universities, gathered in Trento (Italy) on 24 October 2016 to contribute to the 1<sup>st</sup> International Space Forum (ISF) at Ministerial level dedicated to "Space Science and Academy for Global Challenges".

The Forum, jointly organized by the International Astronautical Federation (IAF), the International

Academy of Astronautics (IAA) and the Italian Space Agency (ASI), has been an initiative born under the three-year mandate of the ASI President, Prof. Roberto Battiston, as IAF Vice-President for Science and Academy Relations.

This first ISF was meant to encourage a global discussion on the need of promoting a greater involvement of Universities and national Academies in the conception, design and exploitation of peaceful space missions and



programs and of fostering space knowledge dissemination and capacity building curricula and research activities at local and regional levels.

Three were the topics through which such need was addressed and the global discussion stimulated: Climate Change, Big Data management and Earth Protection.

The first immediate result of the Trento event was the adoption by consensus of the Trento Space Statement, which represents the starting point towards the achievement of the ISF's goals. A coherent, inclusive and balanced action among different Countries could create a worldwide network of space knowledge and human capital through the sharing of intellectual resources and data processing capabilities. Space Science and Academy require adequate referents in each country in order to promote information, exchange of new ideas and standardization of



processes and to create a sustainable network of human resources able to expand a confidence building approach for the peaceful use of outer space.

The International Space Forum is also a contribution to the preparation of the UNISPACE+50 and the goals of the UN 2030 agenda. Next edition of the Forum will be organized at regional level (Kenya's candidature is to be confirmed), in order to enlarge the number of representatives from Universities and academies.

## Participating Countries and Organisations

### COUNTRIES

1. ALGERIA	13. HUNGARY	25. PORTUGAL
2. ARGENTINA	14. IRAN (ISLAMIC REPUBLIC OF)	26. ROMANIA
3. AUSTRALIA	15. IRAQ	27. RUSSIAN FEDERATION
4. AUSTRIA	16. IRELAND	28. SAUDI ARABIA
5. AZERBAIJAN	17. ITALY	29. SOUTH AFRICA
6. BULGARIA	18. JAPAN	30. SUDAN
7. CAMEROON	19. KENYA	31. SWEDEN
8. CHINA CZECH REPUBLIC	20. MALAYSIA	32. SWITZERLAND
9. EGYPT	21. MEXICO	33. TUNISIA
10. FRANCE	22. MOROCCO	34. UNITED STATES OF AMERICA
11. GERMANY	23. NETHERLANDS	35. VIETNAM
12. GREECE	24. POLAND	

### INTERNATIONAL ORGANISATIONS

**ESA** (European Space Agency)  
**ESPI** (European Space Policy Institute)  
**IAA** (International Academy of Astronautics)  
**IAF** (International Astronautical Federation)  
**IISL** (International Institute of Space Law)  
**UNOOSA** (United Nations Office for Outer Space Affairs)

## TRENTO SPACE STATEMENT 1<sup>st</sup> International Space Forum at Ministerial level

### “Space Science and Academy for global challenges”

On October 24<sup>th</sup>, 2016, for the first time Ministries of Science, University and Research, Space Authorities, Space Agencies and International Organizations representatives, senior space experts of 35 countries from Africa, Americas, Asia, and Europe met in Trento (Italy), under the auspices of the International Astronautical Federation (IAF), the International Academy of Astronautics (IAA) and the Italian Space Agency (ASI) for open and productive discussions on how Space Science and Academy can concretely contribute to the sustainability of the future space programs for peaceful purposes.

Governmental representatives and experts presented a valuable and wide range of views and experience which include:

- that Space is not only the place beyond the earth's atmosphere, where planets, stars, and galaxies are, but also where space technology and applications pervade our daily lives;
- that Space is a global environment, able to support and find adequate solutions for global problems and challenges for the benefit of humankind; which requires high level technical and scientific knowledge as well as a multidisciplinary and multitasking approach, suitable for international cooperation;
- that Universities and Academies are distributed all-over the world and they provide the opportunity to establish a worldwide network of knowledge supporting the conception, preparation and exploitation of space activities, regardless of the geographical location;
- that Universities and Academies have different disciplines, competences, technology development, geographic culture, connection to the society and their ability to inspire young generations which have influence and value

Governmental representatives and delegates heard and considered presentations from experts on three main topics:

- ◇ **Climate Change:** the phenomenon which affects humanity in such areas of agriculture, health, sea level and marine ecosystem, forest and water sources.
- ◇ **Big Data Management:** the volume and complexity of Space Systems data could provide a means to explore a variety of data management methodologies;
- ◇ **Earth Protection:** our complex and fragile Planet requires studies, knowledge and intervention capacity implemented on a global level

Governmental representatives and delegates

- noted that these issues have a global impact on the human community and could thus benefit from common understanding, innovative and responsible education, coordinated global responses;
- considered the merit of involving National Academies and Universities in space programs and activities, in particular, to increase local and regional capacity building;
- discussed the need to continue to cooperate in bilateral and multilateral ways through sharing, as appropriate, intellectual resources and data processing capabilities in a coherent, inclusive and balanced approach;



- examined the possibility of a worldwide network of space knowledge and human capital by an inclusive and effective international community of Academies and Universities;
- considered the necessity to globally connect people using space science and research, knowledge and integrated space related applications;
- noted the preparation process in organizing the UNISPACE + 50 promoted by the Office of Outer Space Affairs of the United Nations (UNOOSA) in 2018 to celebrate the 50th anniversary of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE), with the aim to focusing the international attention on global space governance;

All Ministries, Heads of delegations, governmental representatives and experts welcomed the first International Space Forum, viewing it as a starting point to:

- ◇ Involve University and Academy in the conception, design and exploitation of Space missions and programs, sustaining space capacity building curricula and research activities;
- ◇ develop innovative partnerships by using tools and platforms to facilitate access to space strategies and policies;
- ◇ promote open and free access to space based data and information recognizing relevant international instruments and national

policies and legislation; consider the Open Universe initiative proposed by the Italian delegation during the fifty-ninth session of the Committee of on the Peaceful Uses of Outer Space in June 2016 for expanding availability of and accessibility to open source space science data;

- ◇ include University and National Academy expertise, as appropriate, in the governmental agendas to contribute as key element to the global challenges;
- ◇ support the development and implementation of policies towards fulfillment of 3G diversity (Gender, Geography, Generation) in space related activities;
- ◇ Support the development and harmonization of Space Curricula at local, regional and international level paying the greatest attention to developing countries, in particular, concerning sharing of resources and opportunities for access to outer space knowledge for peaceful purposes;
- ◇ discuss means by which the academic community can contribute, on a best efforts basis, to the UNISPACE+50 process recognizing that Space Science can play a pivotal role in the support of the Conference' goals toward the United Nations 2030 agenda for Sustainable Development.

All participants expressed the wish to repeat this Space Forum model at regional level to increase the number of representatives from local scientific communities, Academy and University to prepare new generations of global space leaders.

# IAF Committees

## TECHNICAL COMMITTEES

### Enterprise Risk Management Committee (ERMC)

At the IAC 2015 in Jerusalem, the IAF endorsed the creation of a new Technical Committee: The "Enterprise Risk Management Technical Committee - ERMC". Enterprise Risk Management (ERM) is an important management element for any institution or company to help it track or identify strategic risks, that can have major impacts on its objectives e.g. harming its long-term public reputation, its business model or its income stream.

At the 67<sup>th</sup> IAC in Guadalajara the ERMC held its first committee meeting with ten attendees from different space agencies, research centers or small and big industrial space companies. The first technical session took place as well: E 3.6 introducing several papers related to Risk Management challenges faced by the participants. The challenge for the co-chairs, as it was the first technical session of the ERMC, has been to ensure there was enough interest among the audience.. Counting the participants every 30 minutes, the number was constantly above 20 persons watching all seven presentations. The presenters had been given 20 minutes to elaborate on their papers, and enough time to answer the questions.

At the end of the session every person in the audience was asked to give feedback on why he or she was participating, and what was their interest in the ERM theme. One goal of the ERMC it is to share and communicate actively not only with its members but also to get into direct contact with the audience to ensure the themes presented are relevant. The goal now is to reflect on more feedback rounds, asking upfront for the

expectations of the participants and presenters or even conducting best practices/lessons learned workshops as new element for the ERMC technical sessions. With these elements it is planned to engage the audience in an active discussion, but also for the ERMC to target more in the future their interests.

Despite the positive feed-back received for creating this committee around ERM topics, and the very inspiring presentations, one direct change has been asked by the audience: Indeed, the audience questioned the adequacy of the terminology "enterprise risk management" especially for



public companies. In order to make it clear that ERM is also dealt with by public entities like space agencies, research institutions etc. which look at risks harming their strategic development and business model the ERM decided to use the terminology “strategic risk management” for describing its sessions in the future.

Receiving such a positive feedback for the first year has motivated the ERM to go on with the same enthusiasm as they had started the committee a year ago.



## SpaceLand Center: a dream becoming true

*Carlo Viberti - President, SpaceLand onlus association*

Less than 600 human beings have been flying beyond the Earth atmosphere since the dawn of the space age: they all gave precious and critical inspiration to untold numbers of entrepreneurs, inventors and entire new industries and science research communities as well as to myriads ordinary citizens. Also the vision of many artists and musicians have changed, world-wide, thanks to the beginning of the spaceflight era. However, unless something new gets systematically implemented in the way people and professionals from the world of culture, art and music can get engaged in the ultimate adventure of Space and in the marvellous fascinations of weightlessness, the overwhelming majority of artists and, in general, citizens of our planet will never have the chance to contribute to the expansion of the humankind into the solar system and, related to this, to the opportunities to develop their own skills thanks to the new source of beauty and knowledge stemming from beginning the exploration of our universe, preparing humans to work, live and eventually thrive on the Moon and on Mars.

Filling such a void is among the main tasks of the new SpaceLand Center, a destination of excellence being developed in the Italian island of Sicily thanks to major private funding, with the second objective to generate a twin-center, in the near future, also in other beautiful locations such as on tropical islands in the Indian Ocean. At the SpaceLand Center, artists and people, in general, at any age, will be able to experience actual, direct involvement in Space: the chosen fascinating

location near the Etna volcano will be turned into an amazing “Martian habitat” within a 50.000 m2 terrain providing a breath-taking emulation of the Red planet. The destination will feature futuristic buildings to host a space museum, a space art exhibits with sculpture and paintings produced on board SpaceLand weightless and Mars/Moon-gravity flights, together with underwater and ground training systems and infrastructures allowing artists and laymen to prepare for their respective flight missions, side-by-side with scientists, engineers, technicians, weightless flight veterans and astronauts, also involving people with physical disabilities, following on the SpaceLand legacy at NASA (see records set at the Kennedy Space Center: [www.SpaceLand.it](http://www.SpaceLand.it) ).

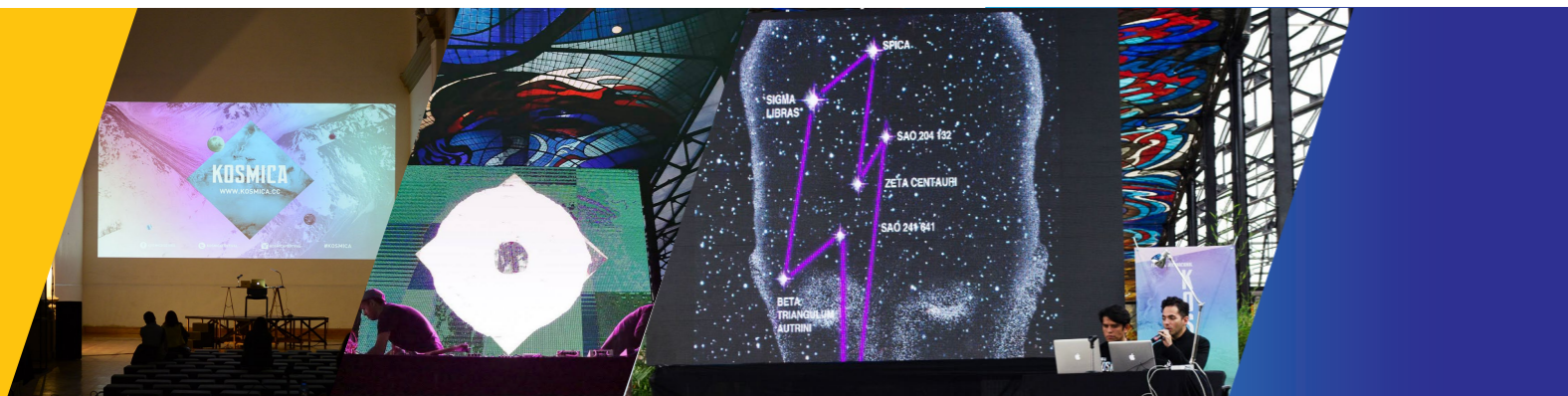
Cutting-edge S.T.E.M. education, technology innovation, biomedical & science research and art in weightlessness, in Moon-gravity and in Mars-gravity, also supporting welfare-oriented initiatives for the poor and generating smiles and opportunities for children, kids and elderly people needing social assistance: all of this will soon be everyday life at the SpaceLand Center.

Space can do a lot of good to humanity, especially these days.

**Welcome to SpaceLand!**

More insight here: <http://simplifieddiscoveries.com/spaceland-opening-microgravity-to-all/>

Check also [www.SpaceLand.it](http://www.SpaceLand.it)



## Committee for the Cultural Utilisation of Space (ITACCUS)

### KOSMICA

KOSMICA is a popular series of events in London, Paris, Mexico City and other places around the world. Each KOSMICA is unique: bringing together the cosmically curious and culturally quirky space community for a social mix of art and outer space programs: film screenings, performances, concerts, workshops, talks and debates about the alternative and cultural uses of outer space.

This series of events and festivals is already an established hub for artists, makers, scientists, astronauts and other space professionals that explore space from the arts and culture. We are in a constant dialogue with the international space community researching the most intriguing and

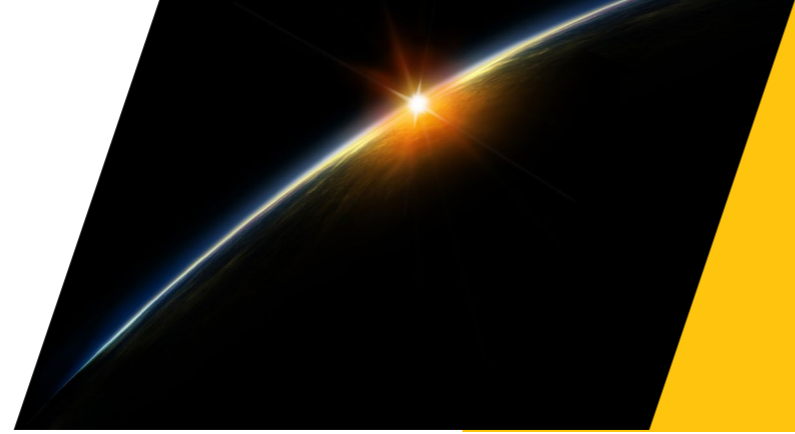
thought-provoking topics. Since our first KOSMICA in London back in 2011, we have presented over 100 artists and space explorers in more than 20 events and festivals in the UK, France, Belgium, Mexico, Canada and more. Currently, it is a series endorsed by the ITACCUS, IAF and organised by Nahum.

During World Space Week 2016 in October, KOSMICA brought a large-scale festival to Mexico State and Mexico City with over 15 international guests and thousands of participants. On this year KOSMICA celebrated its fifth year of activities in Mexico.

## GEOSS Subcommittee

Update from Barb Ryan on GEO

Charts presented – Climate considered cross cutting all areas, not a unique societal benefit area; 103 countries and participating orgs are now a part of GEO, but still some areas still underrepresented and missing especially in Africa, Middle East, SE Asia. It is important that World Bank is getting engaged; must be a UN recognized nation to join, but GEO is not a UN agency. Paul Uhlir US National Academy of Sciences provided major contribution – Value of Open data sharing, made point that GEO is broker, not owner – analogous to Airbnb, Uber; Australian data cube shown, discussed their work to rectify all land sat data pixel by pixel; and they created a national flood portal, showing every pixel always wet, every pixel always dry, etc. Question is why are we not doing this for biodiversity, and other applications; Australia talking with Europe to ingest all the Sentinel data. Make sure agencies are working with census bureaus; GEO leadership is working to get commercial entities involved, private sector organizations can join GEO, but not yet individual companies. Looking at closer cooperation discussions at the upcoming GEO plenary St. Petersburg, Russia in November. Charts will be provided.



coral reef, no detail on host country plenaries. Jim - Chinese Space Agency proposal for a full committee on small spacecraft and commercial applications was discussed. It was decided to address this issue in Adelaide by devoting B5.3 to the subject; this subject has ramifications for sessions B1 and B4. Big topic for future is how to address this push in small spacecraft in context of existing conference structure. Of note, there are 2 GEOSS papers (AmeriGEOSS and AfriGEOSS) in B1.1 of interest; B1.6 on Biodiversity has 5 papers, Friday morning

Discussion on ideas for future EO Plenary Events and Highlight Lectures at IAC Adelaide, IAC Bremen and beyond....Idea: highlight lecture from a superstar lecturer from either inside or outside the community would be good. Mike Simpson suggested Andy Thomas (former Astronaut, big draw) would be good. Have we talked with Adelaide local organizers...yes did in Paris and got good reception, followed up, but did not get response back, In addition to Coral Reefs and Data cube, another option was introduced – water assessment and monitoring. This idea may be combined with data cube, Barb Ryan will provide a linking contact. Jim Graf and others will again follow up with the Australian delegation to re-initiate the discussions to come to closure with them on topics and preparations

B1.6 session topic for Bremen – organizers plan to allow the public to join plenary; may want to put up booth outside for the public to enjoy including 3D or hypercube presentation methods in exposition hall....Consensus was gelled from several inputs on generating a GNF on how key organizations – Governments, NGO's, Commercial are trying to improve service to users considering the major trends and new approaches that are emerging. Another concept discussed for the B.1.6 session was how to engage Citizen Scientist (e.g. using ISS photographs for night time light pollution), several resonated that this could also tie to Young Professionals both with content and making it a virtual sessions to grab broader audience – making it into what is called a Global

Update on Guadalajara events and sessions:

Several spots in the sessions needed to be filled and only one is still outstanding. Brent – at the IAC International Program Committee meeting on Saturday there was discussion of the status of Guadalajara papers (before Brent arrived), while incoming President LeGall briefly noted that he wants to open a dialogue on the future of IAC that will be kicked off in a special luncheon this coming Wednesday; Adelaide – interest in data cubes,

technical session. A group led by Brent Smith will flush out the concept. We are being encouraged to do things differently. Maybe can also make a contest out of it. Lynn to connect team to YPs for discussion this week if possible. Need to tie to theme of what GEO and GEOSS are working on. Potentially tie to Sustainable Development Goals (SDG)s. Theme – Impact through observation Citizen Science, Crowd Sourcing. Brent Lead, Vince, Elizabeth, Gunther, Mike, Chris, Krystal, Barb to support; talk with YPs to see if they are interested and work with them together next March if it is a go. We agreed to Vincent's suggestion to look back at the topics and themes from the last IAC in

Bremen to see if they lent themselves to an update after this many years later.

Young Professionals – High level speakers, getting speakers on panels, can propose EO relevant session, can do sessions that explain how YPs can get linked to societal benefit NGO's, Citizen science etc. Can put YP up with Senior speaker. Go to next generation plenary Tuesday afternoon to see what it is like. Lynn to let YP know how much EO interest there is in participating in the YP programs.



## Astrodynamics Committee

222 – that was the number of abstracts Astrodynamics Symposium received back in spring 2016. This number is low considering that the symposium regularly attracts over 300 submissions. “Will this imply a low turnout at the IAC 2016?” that was the question hanging over the committee throughout the summer 2016. The collective anxiety evaporated as soon as the committee arrived on Sunday. Only handful committee members could not attend due to other obligations. There were very few last minute cancellations. Each technical session averaged over 50 attendees which meets expectation considering that the average could have been even better if “Elon Musk” phenomenon had not been that huge [His press conference affected the Tuesday afternoon technical session attendance]. The IAC finally found an optimal format for interactive presentation session that put both the authors and the audience at the same time. As a celebration, the committee went to a French restaurant. Did we all lose our mind? Not at all as it is authentic French cuisine with excellent service.

In hindsight, the success of IAC 2016 can be attributed first to IAF Bureau for selecting Guadalajara as the host. Secondly, the local host responded with full enthusiasm and professionalism. The venue, the volunteers and the staff were all top notch. In short, IAC Guadalajara has surpassed the expectation of everyone.

*Serious discussion at the committee meeting*



*Happy faces at the committee dinner*



## Space Communications And Navigation Committee (SCAN)

The mandate of the Space Communications and Navigation Committee covers within the IAF all aspects of satellite communications (including fixed, mobile, broadcasting, multimedia, messaging, data relay and navigation satellites), related satellite technology, services and applications and organizes the symposium B2. This symposium examines development in technology, applications and systems as they relate to fixed and mobile communication services, near-Earth and interplanetary communications, satellite broadcasting, position determination, navigation and timing, and interactive multimedia provisioning.

The symposium is grouped into eight sessions:

B2.1 Fixed and Broadcast Communications

B2.2 Mobile Satellite Communications and Navigation Technology

B2.3 Advanced Satellite Services

B2.4 Space-Based Navigation Systems and Services

B2.5 Near-Earth and Interplanetary Communications

B2.6 Advanced Technologies for Space Communications and Navigation

B2.7 Advanced Space Communications and Navigation Systems

B2.8 Space Communications and Navigation Global Technical Session (this is an online session as part of the Young Professionals Virtual Forum)

The order of sessions changes from congress to congress to avoid that only one session suffers from being held at the last day of the congress.

SCAN has currently 28 active members coming from Austria, Canada, China, Czech Republic, Germany, Hungary, India, Italy, Japan, Mexico, Republic of Korea, The Netherlands and USA, representing major organisations such as ESA, NASA, ISRO, NICT, CAST, CASIC, the Galileo Supervisory Authority, KARI, Mexican Space Agency as well as industry (e.g. The Aerospace Corporation, OHB, Tesat Spacecom, SpaceTec Capital Partners) and universities (Johns Hopkins University, Graz University of Technology, Technical University Budapest, University Rome- La Sapienza). At the meeting in Guadalajara two new members were accepted, one from the International

Telecommunications Union-ITU and another one from ESA. More female members joined the committee in recent years. The topic of satellite navigation has been strengthened and the areas of optical and inter-planetary communications included.

The committee is chaired by Otto Koudelka (Austria) and Manfred Wittig (The Netherlands). The secretary is Ramon DePaula (NASA/USA).

The Space Communications and Navigation Symposium attracts every year a significant number of scientists and engineers (typically 110 – 160 abstracts are submitted). At IAC2016 58 papers were finally uploaded.

SCAN organized a panel session at the IAF GLIS conference in June 106 in Geneva: “Big Data and the Information Society”. It addressed the opportunities and challenges coming along with the use of Big Data from, with and for Space systems. Dr. Josef Aschbacher, ESA’s new Director for Earth Observation, Prof. Roberto Battiston, President of the Italian Space Agency, Dr. Ingo Baumann, Lawyer/Partner at BHO Legal, Dr. Hector Fenech, Director of Future Satellite Systems at EUTELSAT, Prof. Irmgard Marboe, Professor of International Law at the University of Vienna and Mr. Andreas Veispak, Head of Unit at the European Union provided insights into the ongoing discussions and presented options and ways ahead to better utilize the benefits of Big Data for the human society, both from a technical and legal perspective.

A plenary proposal has been prepared for IAC2017 focusing on optical communications for Space applications. It is further planned to present the highlights of the Space Communications and Navigation Symposium during the session of the Technical Subcommittee of the UN Committee for Peaceful Use of Outer Space (COPUOS).



## Earth Observation Committee (EO)

The Earth Observation Committee (EOC) of the IAF was created in 1987. Its objective is to cover all aspects of Earth observations from space, especially observations related to the Earth’s environment and including mission planning, microwave and optical sensors and technologies, systems for land, oceanographic, and atmospheric applications, ground data-processing.

The EOC has currently about 30 members from industry, space agencies and academia. Since 2015 it is chaired by Gunter Schreier, DLR (Germany) and co-chaired by Andy Court, TNO (Netherlands). The new appointed secretary is Ralph Girard, CSA (Canada).

The EOC has a Subcommittee on GEOSS, which contributes to fostering IAF activities relating to the implementation of a Global Earth Observation System of Systems (GEOSS). Presently, Membership is open and quite a few Members participate in the sub-committee.

One major task of the EOC is to organize 6 technical sessions and an interactive poster presentation during the International Astronautical Congresses (IAC). The EOC has defined an action plan to expand to more activities, specifically in collaborating with other IAF Sessions and other international organizations. The EOC meets twice per year; during the IAF spring meeting in Paris and during the IAC. The last meeting was conducted a day before the official opening of the 2016 IAC, September 25th, in Guadalajara, Mexico.

The meeting was attended by 21 EOC members and guests. The formal issues at this meeting included the finalization of the organization of the 6 EOC sessions in Mexico. 45 oral presentations and 13 poster presentations were scheduled

for the 2016 IAC. As generally observed by the IAF secretary for all sessions, also the EO sessions experienced a certain decline of paper contributions. In addition, the Committee discussed, on how to increase the attractiveness of the sessions and to avoid too many no-shows in the sessions. Plans and proposals for Earth Observation related IAC Plenary and GNF events, were discussed and will be followed-up for the selection by the IAF secretariat.

The meeting also reviewed the session planning for 2017 (Adelaide), specifically the theme of the GEOSS Subgroup session, which was defined as “Big Data, Data Cubes and new platforms to exploit large-scale, multi-temporal EO Data”. The meeting also discussed ideas for the IAC 2018 in Bremen, Germany. Prof. Christiane Schmullius, University of Jena and Programme Chair of the IAC 2018, took part in this discussion. Together with other candidates, she was also welcomed as a new member of the EOC.

*Gunter Schreier, IAC-EOC Chair*





## Committee on Integrated Applications

Integrated applications can offer solutions to global problems like the unpredictable spread of disease, the difficulty in predicting natural disasters, and variable food security. They are products or services that use a combination of Earth observation, satellite communication, satellite navigation or human spaceflight technologies and integrate those with terrestrial capabilities. The potential added value of space remains unknown to many areas of industry; the Integrated Applications Technical Committee (IATC), established by the International Astronautical Federation, has the aim to explore and promote the potential of integrated applications for various users.

The Integrated Applications Technical Committee met at IAC2016 on Sunday, 25<sup>th</sup> September 2016 and was chaired by Prof. John Horack, IAF Vice President and Neil Armstrong Chair in Aerospace Policy at The Ohio State University.

The Committee agreed to propose to the IAF Technical Committee to establish a Select Committee on Small Satellite Commercial Applications. This Select Committee will be formed by professionals from across IAF member organizations, in coordination with the International Academy of Astronautics. The existing Integrated Applications Technical Committee will serve as the umbrella-sponsor for the Select Committee, under which the IAF can enable and connect various stakeholders in the small satellite commercial application community. Moreover, the Committee agreed to instantiate

a new session B5.3 entitled Small Satellite Commercial Applications in the Symposium on Integrated Applications starting at IAC2018.

*“In the areas of agriculture, resource management, disaster response, maritime security and more, the proliferation of satellite-derived and satellite-supported integrated commercial applications has opened entirely new opportunities for business, scientific research, and humanitarian support,” noted IAF Vice-President Dengyun YU. “We are very happy to have helped formulate the leadership of this Select Committee, enriching the existing integrated applications program, and enabling the IAF to serve as a coordination and enabling function to a wide variety of stakeholders.”*

At IAC 2016 the Integrated Applications Technical Committee organized and chaired two technical sessions related to Integrated Applications. These were B5.1 ‘Tools & Technology in Support of Integrated Applications’ and B5.2 ‘Integrated Applications End-to-End Solutions’. Numerous fascinating papers were presented. Some of the most novel ideas are covered here.

### HYPERSPECTRAL OBSERVATIONS OF VEGETATION PHENOLOGY AT HOURLY TIMESCALES WITH A CONSTELLATION OF SMALL SATELLITES.

*EPFL and eSpace, Switzerland.*

The Mission, called SOLVE, was driven by the needs of farmers to get data, which would help them

to decide what best to do in the field, on a daily basis. The mission used Sentinel data and involved drones to observe cyclic and seasonal changes in vegetation at an hourly rate.

### THE FIRST UAE MULTI-DISCIPLINARY SPACE PROGRAM – A CUBESAT TO MONITOR VEGETATION AND DEMONSTRATE NEW TECHNOLOGY.

*Masdar Institute, UAE.*

This programme focused on the need within the UAE to monitor vegetation and gain an understanding on how urban expansion is affecting vegetation growth.

### CAPSULE: A FAULT-TOLERANT MULTI-CLOUD STORAGE SERVICE FOR SATELLITE IMAGERY.

*Unidad Tamaulipas Laboratorio De Tecnologías De Información, México.*

Traditional satellite image delivery is easy to install but costs a lot and uses many resources. Public cloud storage is beneficial because the user can access data anytime. However, there is an issue with lack of control, reliability, security and privacy and it costs a lot to change provider. This paper proposed a “community multi-cloud”, with each industry gaining control over the own cloud.

### SPACE ORBITING SPECTROSCOPY TO CHARACTERISE AEROSOL EMISSIONS OF MEXICO’S POPOCATEPETL VOLCANO

*La Universidad Popular Autónoma del Estado de Puebla, México.*

The aim of the CubeSat mission was to characterise aerosol emissions on Popocatepetl Volcano - one of the most active volcanoes in Mexico and North America. 25 million people live within 100km of the crater so it is one of the most dangerous volcanoes in the world. Issues include acid rain falling and aerosol emission. The CubeSats were designed to observe aerosols in the middle atmosphere.

### UP-SCALING REGIONAL OIL SPILL MANAGEMENT SYSTEMS FOR GLOBAL REQUIREMENTS: NEEDS AND CONTRIBUTIONS OF INDIA,

*ISRO, India.*

Marine oil spills are a global concern. SAR is used to detect and monitor oil spills. Initiatives in the UAE, Europe and Canada exist. However, these

technologies are not, but should be, integrated. This paper noted that any framework covering oil spill management systems ought to assimilate data from a wide range of sources such as satellite data, GIS platforms, shipping routes, and vessel information. It stressed the importance of international cooperation regarding data sharing.

### AIRCRAFT MONITORING BY THE FUSION OF SATELLITE AND GROUND ADS-B DATA

*Shanghai Engineering Centre for Microsatellites, China.*

The Shanghai Engineering Centre for Microsatellites (SECM) was founded by the Chinese Academy of Science and has developed 14 micro/small satellites. Variflight is a commercial company developed in 2005. The STU-2 mission consisted of 2 and 3 Unit CubeSats and aimed to monitor civil aircraft traffic information, to monitor sea ice status in polar regions, and to gain maritime traffic information via AIS receiver.

### DISASTER MANAGEMENT OF REMOTE AREAS BY CONSTELLATION OF CUBESATS

*Universidade de Brasilia, Brazil.*

A simulated disaster was monitored from 9am – 2pm. It was discovered that after a disaster, many temporal holes existed where data could not be collected. The proposed solution proposed using a satellite constellation such as Planet Labs or Terra Bella or Cubesats, which could be used to provide environmental data, weather information, and emergency reports from ground networks. This would reduce the total cost of the system, increase revisit time, and reduce the risk of loss of the service in case of a single failure. The 3U Cubesat has been used for some case studies, including flood monitoring and monitoring of the Amazon forest. Cubesats are becoming increasing popular and can overcome the revisit time limits of very high spatial resolution satellites.

## Knowledge Management Technical Committee (KMTC)

Working on complex space missions requires virtual teaming, learning lessons, sharing knowledge between generations, and developing deep expertise within an organization.

Knowledge Management is thus fundamental to space activities. It is universally advantageous when experiences and best practices are shared between space agencies, companies, universities and professional societies. The International Astronautical Federation established the Knowledge Management Technical Committee (KMTC) to promote the importance of knowledge management and the sharing of new techniques between individuals, teams, and organizations.

The Knowledge Management Technical Committee met at IAC2016 on Wednesday, 28<sup>th</sup> September 2016 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 potential new activities to be undertaken by the Committee. In this respect, the Committee agreed to support the International Knowledge Management Workshop to be held on the premises of DLR, Germany. This Workshop is planned for June 2017 and it can be seen as the continuation of the International KM Conferences organized in previous years by the Committee in NASA, ESA and CNES. The committee also decided the creation of a working group on “Model Based Systems Engineering (MBSE)” to establish a proposal on the way to address it, in particular in liaison with the “System Committee” (see details in the summary of “ADVANCING MODEL BASED SYSTEMS ENGINEERING IN AEROSPACE PROJECTS” presentation).

At IAC 2016 the Knowledge Management Technical Committee organized and chaired one 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.

### NASA'S PUBLIC-PRIVATE PARTNERSHIP ROUNDTABLE: OVERVIEW AND OBSERVATIONS

NASA, USA.

A lot of talent is held within NASA, but initiating change can be difficult; NASA's buying power has been eroding over the past 25 years and the organization must therefore adapt. Historically, many programs, particularly human spaceflight programs, were cancelled. Meanwhile, over the past 10 years, private investment has increased, implying that NASA ought to do more Public-Private partnerships (PPPs). This is not a well understood concept at NASA because NASA was traditionally involved in cost-plus contracts and had a lot of control over projects because NASA owned assets and had detailed requirements.

The objective of this paper was to explore whether connections could feasibly be established and sustained across the agency between personnel and whether knowledge about PPPs could be shared. A roundtable was set-up and structured to be inclusive of the various ways in which NASA could not only use PPPs to achieve agency objectives, but examine how these PPPs could be managed effectively once the partnership was operational. NASA learnt that they must capture the knowledge from successful partnerships, and implemented a Knowledge Capture website which can be viewed publicly. Furthermore, there is an ongoing need to better educate the NASA workforce on the importance of Knowledge Management.

### MATRIOCHKA SPACE PROJECT D55

France

The aim of this space project was to design and build 2 rockets; a launcher called Stimulus and a payload called Reflex. The main difficulties faced during this project was knowledge transfer. Many people volunteered their time and so the adopted ethos was to “work as if a completely new team

would finish the project”. The original team implemented a four stage process:

1. Training (observe former members, understand, and learn)
2. Apply (apply and repeat)
3. Transmit (teach your knowledge, use the tools and show others how to use the tools)
4. Innovate

A database, physical file and network was used to store knowledge and keep track of former members of the association.

### ADVANCING MODEL BASED SYSTEMS ENGINEERING IN AEROSPACE PROJECTS

University of Alabama, USA.

Model Based Systems Engineering (MBSE) is a system engineering methodology that uses computer models to exchange information and data.

There are several advantages of MBSE in aerospace:

- easy to see how requirements are being fulfilled because everything is already on a computer.
- ties engineering disciplines together
- enables data exchange
- automatically monitors simulations and script
- allows procuring agency to establish user requirements
- defines model-based deliverables

However, disadvantages also exist:

- there are a variety of tools
- even experts lack experience in some tools
- there needs to be clear definition of data standards
- there are potential changes in tool / data standards after kickoff.

A lab environment was created at the University of Alabama to explore MBSE. The next steps of the investigation into MBSE include improving collaboration with government, industry and academia, develop and improve tools and methodologies, and share lessons learned. The

goal of the investigation was to provide best practices for MBSE.

Two main conclusions were drawn:

1. MBSE is the next step up from document centric approach.
2. A coordinated effort in the aerospace industry is needed

### CNES TCC: AN OPEN INNOVATION TOOL INGESTED IN CORPORATE INTERNAL CULTURE

CNES, (France.)

Technical community communities (TCC) is a knowledge club set up to bring together experts focusing on the main scientific and technical disciplines. It is part of CNES's technical policy.

There were three goals behind the TCC:

Goal 1: To create active communities focused on excellence. To feed the expertise and contribute to innovation, enhance professional experience, and allow cross-fertilisation.

Goal 2: To cover the main relevant technologies and methodologies used in the space sector.

Goal 3: To Gather openly

Each CCT is led by a manager and the Global TCC coordination grants TCC logistical and financial supports, promotes cross-fertilization, and organizes assessments of results and process every two years be a directors board providing orientations for the next period.

There are 19 TCCs (most are technical). Overall, the TCCs consist of 40% CNES, 40% Industry and 20% Research. There are 65 seminars per year and 5000 participants.

TCC is altogether an open innovation model, a KM tool, and a people technology process. Future steps are to conciliate open sharing and economic intelligence and to improve sharing between space sector and non-space sector.

### THE PROJECT IS OVER – THE KNOWLEDGE IS LOST? DLR'S PROJECT DATABASE

DLR, (Germany)

DLR wants efficient knowledge creation through:

1. Socialization (knowledge sharing meetings, people's directory, onboarding new employees,



knowledge transfer for leaving employees)  
 2. Transparency (optimized search, DLR-wide Wiki, Project Database)  
 A project database was established with the requirement that project descriptions had to be succinct and readable. One way of ensuring that a layperson could understand was to use a 'wiki format' where one could click on a linked word to find a definition.

It was discovered that the wiki covers the last 3

of the so called 5 moments of need. It supports whenever problems must be solved and finding the "right" person is essential:

1. Learn something the 1st time
2. Learn more of something
3. Try to remember/apply
4. Adjust to change
5. When something fails or goes wrong – break/fix.

The new system within the DLR internal wiki

allows people to search for projects with links showing relations between project and tools used and topics researched. From the linked page one can see which projects are related to other projects. This helps to find colleagues within DLR which are working with the same tools or topics. Shareholders are now requesting that the database is maintained and is therefore seen as a success.



## Space Transportation Committee

### 1. D2 Meeting during IAC2016

According to our tradition, we Space Transportation Committee held our meeting on Sunday, just before the opening ceremony of IAC2016. This is a very important preparation of the 9 technical sessions we are in charge of. Our chair, Mr. Steve Creech from NASA hosted the meeting in room Degollado 2.

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 D2 Meeting, we carefully prepared every session and confirmed the co-chairs and



Mr. Steve Creech, chair of IAF STC, hosted the D2 Meeting.

rapporteurs of each session. We have gained a great success for these efforts, even during the last day of the congress, many delegates were attracted to Salon Jalisco E2 and attended our sessions.

The vote of new member is always an important part of the committee meeting. This year our new



Far Left: D2 Meeting in Room Degollado 2

Left: Our New Member, Pier Michele Roviera from ESA

candidate, Mr. Pier Michele Roviera came to our meeting and introduced himself. He now works for ESA on Launch Vehicle affairs and has worked for the development of Ariane 4 and Ariane 5. All attendees of the meeting agreed to welcome Pier to our committee.

### 2. D2 Dinner during IAC2016

In every IAC, we D2 committee have dinner on the fourth day of the congress. This year we chose Casa Basiachi in downtown, Guadalajara. Members all over the world came together and enjoyed the happy night!



Finally, the smiling faces!

### 3. D2 Members on China Central Television

Just after the IAC, China accomplished its Tiangong-2/Shenzhou-11 Manned Mission. Two astronauts were flying to Tiangong-2 Space Laboratory. After 33 days in Space return to the Earth by Shenzhou-11 Spaceship.

Bing the studio guest of China Central Television (CCTV), Prof. Yang Yuguang, secretary of D2 committee also suggested CCTV to invite Dr. Christian Feichtinger to attend the talkshow about China's space activities. Yang and Feichtinger discussed the role and importance of IAF in future space cooperations.



D2 Dinner!



Inviting Christian Feichtinger to the talkshow of China Central Television



# IAF Committees

countries attended the workshop, listened to the lectures and then spent discussion time. This workshop is expected to contribute to the diffusion of the utilization of satellite information to emerging countries.



## ADMINISTRATIVE COMMITTEES

### Asia-Pacific Regional Group

#### Special Exhibition Booth for Emerging Countries

A special exhibition booth was set up to promote IAF regional group activities and strengthen communication by sharing space development status of emerging countries during the IAC 2016 in Guadalajara. IAF regional group was established through the IAC 2009 Daejeon Declaration and consists of Asia-Pacific Regional Group (APRG), African Regional Group (ARG), and Regional Group for Latin America & the Caribbean (GRULAC). Five emerging countries (Philippines, El Salvador, Uruguay, Costa Rica, Ecuador), APRG and GRULAC exhibited posters and brochures to introduce their space activities. During the IAC 2016, many experts and government officials from emerging countries gathered around the exhibition booth to communicate and discuss with people from other countries.



#### Special Workshop for Emerging Countries

Satellite Application Workshop for emerging countries on Resources and Disaster Management using Satellite Information was held during the IAC 2016. This workshop was organized as one of the activities of IAF Asia-Pacific Regional Group which is chaired by Dr. Eunsup Sim. The lecturers were Mr. Giancarlo Filippazzon (Copernicus Program Coordinator, ESA), Dr. Frank Webb (Deputy Manager for the

Earth Science, NASA), Dr. MVR Sessa Sai (Group Director, National Remote Sensing Centre, ISRO), Dr. Eunsup Sim (Research Fellow (Former VP), KARI), Mr. Heegu Park (Manager, Marketing/Business Development, Spaceware Inc.). The lecturers introduced their own practices of satellite information utilization on disaster monitoring. Dozens of people from emerging

### KARI International Space Training Program

In May of 2016, the 7<sup>th</sup> KARI (Korea Aerospace Research Institute) International Space Program was held with 25 participants from 14 emerging countries. It was initiated in 2010 after the 2009 IAC in Daejeon, Korea. The objectives of this program is to develop the capability of space technology R&D and its application of experts from developing countries and to contribute

to solve the global problems e.g., natural disaster, climate change, etc. utilizing space technology by networking cooperative relations with participating countries. This two weeks program covers satellite manufacturing, satellite application, space launcher system, and space policy & law. Since 2010, total 158 experts from 30 countries participated in the program.



## Museums And Science Centres Committee

### A New Administrative Committee

The Space Museums and Science Centres committee was officially created during the General Assembly of IAF during the IAC 2015 in Jerusalem. During previous IAC and Spring Meetings, some preliminary meetings were held in order to ensure sufficient interest from potential members.

The constitution of a Museums and Science Centres Administrative Committee within the IAF follows the eligibility of these institutions to become IAF members.

This new eligibility was a recognition that Space Museums and Science Centres are relevant actors in the space field. Museums are the custodians of much of the material cultural heritage of space activities. Space Museums and Science Centres are main players in informal education towards a large public. They are essential actors when it comes to increase public understanding of space activities. In many societies where the interest of the younger generation for taking on scientific and space related careers is decreasing Space Museums and Science Centres have a vital role to play, in close interaction with all space actors.

The Administrative Committee has therefore a goal of becoming an active platform of exchange between its members and friends

### Membership

The initiative of creating a Space Museums and Science Centres Working Group and then a full Committee has drawn interest from IAF members, and many members attended them. There is obviously the will to create strong ties with other actors of the space outreach community.

24 members have now fully joined the Committee, and we hope to increase this number in the coming years, encouraging Space Museums and Science Centres to join the IAF.

### Committee Activities

During the Spring Meeting 2016, and following some recommendation from new members, the meeting had a special focus on "Space Heritage

Curatorship". Two members presented the state of space heritage in two different countries: Ukraine and France. This presentation was followed by a discussion on curatorship issues of space artifacts, and their specificities.

The Space Museums and Science Centres Committee has the aim to foster interactions between its members, but will also aim to reinforce the links between its members and players of the major space agencies and industries. This is why it has been decided to invite during the IAC Committee Meeting a representative from the national space agency hosting the meeting, this year Mexico, especially involved in public outreach, and to have him/her presenting their activities, in order to allow for possible joint projects. We also are planning on having related visits during the IAC (Space Museums, Planetariums etc.).

In the future, there is the will to share and develop joint projects, in the area of exhibitions, curatorial affairs, educational initiatives, marketing etc. This Committee shall also be a vehicle for promoting space activities in space-developing countries.

The Committee is closely working with the Space Societies Committee, both structures being dedicated to encourage and develop space awareness and education.

### Committee Activities Related To IAF

The Committee took part to the organization of the IAC 2016 symposium on Space and Society (E5) by participating in the paper selection, undertaking session co-chair together with the Space Societies Committee and SGAC representative (Space Societies, Professional Associations and Museums E5.5)



The following presentations were done during the symposium:

- A Mars Yard in the Museum: Research Education and Outreach
- The role of astronauts in the diffusion of space culture
- Children Space Congress: when the young ones are in charge
- Space Activities in Ethiopia
- Space Museum 2.0
- Spaceboard, the professional network of space industry
- Shaping the space technology roadmap.

The attendance was higher than the previous year (30/50), maybe due to less schedule conflict with related symposiums and sessions, like the ones related to space education (E1).

### Challenges

In spite a very positive start of this Committee, some challenges have also appeared, that the Committee will need to address. In order to reach its goal, the Committee needs to create a stable core community of actors, which requires that its members gathers at least once a year. But on

the same time, like any other cultural institution, Museums and Science Centres have very limited travel budget, which makes them difficult to attend to Conferences or Spring Meetings on a regular base.

In order to overcome these challenges and to create this starting core community, able and committed to attend at least one of the two annual meetings, we believe that creating joint outreach projects is a good option, as it is to offer special presentations and visits during Spring Meeting and IAC.

We believe that organizing some joint events during the World Space Week is a good opportunity to work together towards our publics and we will try to do so in the coming years.



## Committee for Liaison with International Organisations and Developing Nations (CLIODN)

The Committee for Liaison with International Organisations and Developing Nations (CLIODN) advises the President and the Bureau of International Astronautical Federation on opportunities to foster international cooperation in space programmes, to encourage public interest in astronautics and its application in developing countries and to promote interest in using space science and technology for national development activities in all countries. The Committee acts as liaison with international organisations, governmental and nongovernmental, and provides advice to the Federation on relations with these international organisations. In particular, the Committee considers and recommends steps to stimulate interest in the Federation's activities among institutions and individuals from the developing countries, taking into consideration the emergence of space activities in several developing nations.

The Committee Chair and committee members work closely with the IAF Secretariat and with the United Nations Office of Outer Space Affairs in supporting approved projects including the annual Highlight in Space report on outer space activities and the UNIAF Workshop on the Use of Space Science and Technology for the Benefits of Developing Countries held in conjunction with the International Astronautical Congress. This year's UN/IAF workshop focused on "Integrated space technologies and applications for better society". The workshop aimed at arriving at observations, recommendations and concrete ideas on how



UNISPACE+50 could be utilised to achieve progress on thematic priority 7 "Capacity-building for the twenty-first century", which will also support the implementation of the 2030 Agenda for Sustainable Development. The workshop included eight thematic sessions and attracted high level speakers from a number of institutions.

Additionally, this year the CLIODN Committee jointly organised and moderated with the IAF Vice President for Developing Countries and Emerging Members the Global Networking Forum on Space Technologies for Emerging Countries. The event included a welcome video by David Nabarro, UN Secretary General's special advisor on the SDGs. Presentations followed by Simonetta Di Pippo, Director of UNOOSA, Josef Aschbacher, Director of Earth Observation of ESA, Dava Newman, Deputy Administrator of NASA, Luc St-Pierre from UNSPIDER of UNOOSA, Francisco Javier Mendieta Jiménez, Director of AEM and Jörg Feustel-Büechl, Advisor to the Bavarian State Ministry for Economic Affairs and Media, Energy and Technology. The event was moderated by Joo-Jin Lee VP for Developing Countries and Emerging Members and Christina Giannopapa, CLIODN Chair.



## THE INTERNATIONAL ASTRONAUTICAL FEDERATION

### WHO WE ARE

Founded in 1951, the International Astronautical Federation (IAF) is the world's leading space advocacy body with 327 members from 66 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 organiser 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 organisations 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



# Upcoming



## IAF SYMPOSIUM

*What is at stake in space in 2017 and 2018*

VIENNA, UN COPUOS/STSC - 8 FEBRUARY 2017

## SPRING MEETINGS

PARIS, 21-23 MARCH 2017



GLOBAL SPACE EXPLORATION  
CONFERENCE (GLEX 2017)  
**6 - 8 June 2017**  
Beijing, China

[www.glex2017.org](http://www.glex2017.org)

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