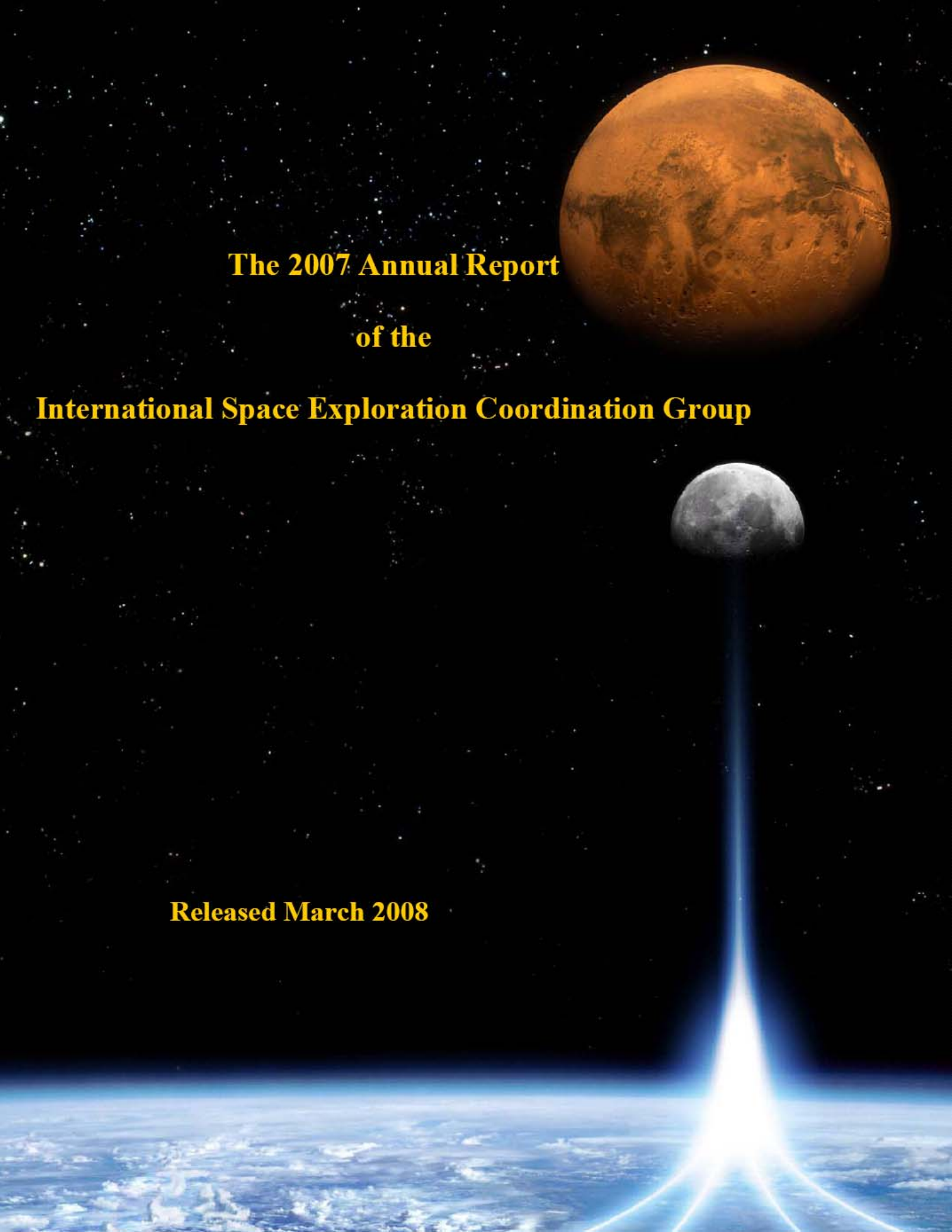

The 2007 Annual Report

of the

International Space Exploration Coordination Group

Released March 2008

International Space Exploration Coordination Group
Annual Report: 2007

Introduction

The International Space Exploration Coordination Group (ISECG) intends to issue a Report each year that will highlight its activities during the past twelve months, report on progress of its Workplan, and the work ahead. In addition, the ISECG Annual Report provides an opportunity for agencies to update the international community on their individual space exploration plans. The Annual Report is intended to keep all exploration stakeholders better informed of the ISECG's work and importantly to ensure that other exploration related coordination groups are fully informed.

This first Annual Report of the ISECG provides, in addition to the highlights to be included in each Report, a synopsis of the background to the creation of the ISECG.

Background to the ISECG

In 2006, 14 space agencies[1] began a series of discussions on global interests in space exploration. Together they took the unprecedented step of elaborating a vision for peaceful robotic and human space exploration, focussing on destinations within the Solar System where humans may one day live and work, and developed a common set of key space exploration themes. This vision was articulated in "The Global Exploration Strategy: The Framework for Coordination" (the Framework Document), which was released on May 31, 2007[2].

The process of creating, editing, and producing the Framework Document has nurtured a strong consensus and partnership among the fourteen founding space agencies. This spirit of openness, flexibility, and mutual respect that marked the Framework Document development process yielded a truly cooperative effort and the starting point for broader discussions with an increasingly wider set of participants, both among and outside the founding fourteen agencies.

A key finding of the Framework Document was the need to establish a voluntary, non-binding international coordination mechanism through which individual agencies may exchange information regarding interests, objectives and plans in space exploration with the goal of strengthening both individual exploration programs as well as the collective effort. The coordination mechanism is now called the International Space Exploration Coordination Group (ISECG).

[1] In alphabetical order: ASI (Italy), BNSC (United Kingdom), CNES (France), CNSA (China), CSA (Canada), CSIRO (Australia), DLR (Germany), ESA (European Space Agency), ISRO (India), JAXA (Japan), KARI (Republic of Korea), NASA (United States of America), NSAU (Ukraine), Roscosmos (Russia). “Space Agencies” refers to government organizations responsible for space activities.

[2] Posted on each of the agencies websites

It is important to note that the Framework Document was clear concerning the Principles and Resulting Requirements that would govern the ISECG. The guiding Principles are:

- Open and Inclusive
- Flexible and Evolutionary
- Effective
- Mutual Interest

It is acknowledged that the ISECG may evolve incrementally, as required, to meet the changing needs of the Participating Agencies. It is further agreed that the ISECG is open to space agencies which have or are developing space exploration capabilities for peaceful purposes, and which have a vested interest to participate in the strategic coordination process for space exploration. In sum it is not an exclusive club of the fourteen agencies that developed the Framework Document. The ISECG will work in accordance with an agreed Workplan that will be periodically up-dated as new activities are identified, with concrete "deliverables". Also, it is not the intent of the ISECG to either duplicate the work or govern the work of other coordination groups, for example the International Mars Exploration Working Group (IMEWG) or the International Lunar Exploration Working Group (ILEWG), but rather to "work with" these, and other groups to ensure that ISECG Workplan activities are being covered.

The Terms of Reference for the ISECG were developed and agreed by the beginning of the ISECG's first meeting that was held in Berlin November 6-7, 2007. The meeting was co-chaired by DLR and ESA with twelve of the original fourteen agencies, which developed the Framework Document, participating[3].

Report of the 1st Meeting of the ISECG

The first meeting of the ISECG dealt with necessary administrative matters including a discussion of the creation of a secretariat. For the purposes of this Annual Report we will focus on the three topics that will be of interest to a broader readership.

Relationship with existing working groups:

A comprehensive overview of existing international working groups, committees and organisations, with relevance to exploration was presented by NASA. As a result of the discussion all participants understand that ISECG will not try to coordinate other groups but shall take advantage of already existing information and expert assistance if required to accomplish the objectives of the ISECG.

Space Agencies Exploration Plans:

Each agency present provided an overview of their exploration activities. It was decided that the Annual Report should include a one-page summary from each ISECG participating agency covering: Exploration Highlights, Recent-Past Significant Events/Milestones (missions launched, studies initiated etc), Upcoming Significant Events/Milestones. Annex I to this Annual Report provides the first edition of the Space Agencies Exploration Activities.

[3] ASI, BNSC, CNES, CNSA, CSA, CSIRO, DLR, ESA, JAXA, NASA, NSAU, ROSCOSMOS

ISECG Workplan:

After a collection of various proposals and clarification of their content, a general debate took place about the role of ISECG and its awareness within the agencies and externally. It was clarified that the work plan shall lead to concrete products and deliverables, which demonstrate the "fruitfulness" of international coordination.

The Workplan was further refined after the Berlin meeting with a final Workplan being accepted by the ISECG in January 2008. Highlights of the 2008 Workplan are given below.

ISECG Workplan 2008

The Terms of Reference for the ISECG state that the scope of the ISECG activities will be broad and strategic. The ISECG will focus on developing non-binding findings, recommendations and other outputs as necessary for use by Participating Agencies.

The Terms of Reference also list areas of activity for initial consideration by the ISECG as:

- identification of standards to promote interoperability;
- methods for sharing scientific data and related analyses;
- identification of common services, allowing for the development of shared infrastructures;
- mechanism(s) to allow the provision of payload opportunities;
- ways and means to include broader future participation in the planning and coordination process;
- assessment of the requirements for any relevant international legal agreements; and.
- development of a common international exploration coordination tool to enhance the implementation of the coordination process.

Specific Actions for 2008

The following specific actions have been identified for 2008:

- Development of recommendations regarding space exploration infrastructure standards facilitating interoperability through establishment of a working group.
- Development of Prototype version of the INTERnational Space Exploration Coordination Tool (INTERSECT)
- Enhancement of public engagement
- Establishment of working relationships with relevant existing international working groups/ organisations.
- Development of an annual report

Space Exploration Infrastructure Standards

The objective of this activity is to identify high-priority space exploration element interfaces recommended to be common that would maximise opportunities for international cooperation in an open architecture environment.

INTERSECT

International Space Exploration Coordination Tool. The "intersection" of the world's exploration plans. INTERSECT is perhaps at the core of ISECG work. It is this tool/database that will best help to identify areas for cooperation in the implementation of the Global Exploration Strategy.

A special team of ISECG members will focus their work during 2008 on the development of a prototype of INTERSECT that will provide integrated and validated information on international space exploration plans (roadmap view), associated exploration capabilities and systems (architecture view) and related exploration goals (interests view).

Public Engagement

The goal is for a Working Group to develop key elements for public engagement that would be useful for participating Agencies to promote exploration.

Relationships with existing international working groups

The objective is to establish a working relationship with relevant existing international working groups of mutual benefit through

- Informing existing groups of the existence of ISECG, its mandate and activities
- Acquiring a better knowledge of the activities of existing groups
- Initiating collaborative activities, as appropriate.

A number or areas have already been identified which are of particular relevance for the objectives of ISECG and which would greatly benefit from close contact between ISECG and existing working groups. Examples of such activities include:

- Development of exploration data archiving and distribution standards: Objectives of this activity include expanding standardisation efforts for data archiving and distribution from space science to the exploration community to ensure accessibility of data among participating Agencies. Related issues are currently addressed by the International Planetary Data Alliance.

- Development of standards to support space exploration communications interoperability: Objectives of this activity include monitoring progress from those agencies actively planning spacecraft beyond Low Earth Orbit (ESA, CNSA, ISRO, JAXA, NASA and Roscosmos) to continue the Space Interoperability dialogue that occurred on October 27, 2007 as well as other fora. Further advantage shall be taken from ground infrastructures suited for deep space communications. Working groups dealing with related issues are

the Space Frequency Coordination Group, the Interagency Operations Advisory Group and the Consultative Committee on Space Data Systems.

- Development of a common lunar cartographic reference system: Objectives include definition of a common lunar reference system by the end of 2008. Working groups dealing with related issues are the International Lunar Exploration Working Group, the International Astronomical Union (IAU)/IAG Cartographic Working Group and the Interplanetary Planetary Data Alliance (IPDA).

Agency Initiatives in Support of Future ISECG Activities

The ISECG is also discussing agency initiatives, which may lead to ISECG activities in the future.

One such initiative on "Code-Sharing Payloads and Related Mediation Mechanism" has been presented at the 1st ISECG meeting by JAXA. The major objective of this proposal is to develop a mechanism, which facilitates and regulates the exchange of space exploration mission payload opportunities between Agencies.

While the objectives of this activity are promising, further work is required for the preparation of a future ISECG activity proposal. This idea will be therefore be discussed within ISECG during 2008 with the objective to develop a consolidated proposal for future consideration and implementation. Status presentations on this activity will be made at the ISECG meetings planned for 2008.

Outlook

The ISECG has set the stage for a truly cooperative effort and the starting point for broader discussions with an increasingly wider set of participants.

The ISECG Workplan is pragmatic and its products will make a major contribution to the furtherance of a robust international cooperative space exploration program, with a particular emphasis on those destinations in the Solar System where humans may one day live and work (i.e. the Moon and Mars).

Most agencies' exploration plans are in formation thus we have a unique opportunity to help coordinate these plans such that we can collectively achieve a more robust and rewarding space exploration program.

ANNEX I

HIGHLIGHTS
of
SPACE AGENCIES'
EXPLORATION ACTIVITIES

ASI/Italy
Exploration Highlights

Introduction

The year 2007 has been characterized by several events related to Exploration, both robotic and human, among which it is worthwhile to mention the STS120 flight with on-board the European Astronaut of Italian nationality Paolo Nespoli and the Node 2 in the Shuttle Cargo Bay. Node 2 is an ESA contribution to the ISS and it has been developed in Italy (Thales Alenia Space – Italy) under ASI management. Another important achievement has been the launch of the NASA Discovery mission Dawn towards the asteroids Vesta and Ceres with on-board the Vis-IR mapping spectrometer VIR, entirely designed and developed in Italy (INAF and Galileo Avionica S.p.A.). Many other achievements were reached and are reported with more details hereafter.

Past significant events and missions

Hereafter are reported the significant events related to exploration during the past year:

Human exploration

- Esperia mission (STS120) with ESA with on-board P. Nespoli and Node 2, which is a pressurized module attached now to the ISS and to which Columbus and Kibo laboratories will be attached. The Esperia mission derives from the so-called MPLM NASA-ASI agreement where ASI provided to NASA 3 MPLM modules for ISS and NASA provided ASI 6 astronauts flights and utilization resources on the Station, including astronaut time.
- Participation as the main European contributor to the joint ESA-Roscomos preparatory study and breadboarding on CSTS (Crew Space Transportation System).
- Life Support System activities (CAB Controllo Ambientale Biorigenerativo).
- Conclusion of the Phase B1 activity related to inflatable modules for ISS and/or planetary exploration for what concerns requirements definition.

Robotic exploration

- Dawn launch with on-board the VIR instrument.
- Operations, data acquisition and analysis of Italian instruments on-board Mars Express (MARSIS and PFS) and NASA MRO mission (SHARAD).
- Together with European partners, phase B1 of ExoMars (Prime Contractor TAS-I) and activities related to P/Ls development (4 instruments plus contribution to other 5).
- Development of 2 P/Ls for the Russian Phobos Grunt mission plus contribution to another one.
- Initiation of a joint mission study together with JAXA to assess the feasibility to launch the Hayabusa-2 mission with the VEGA launch vehicle.

Earth based activities

- Development of a field infrastructure in Morocco for field testing for robotic Mars exploration technologies (rovers mobility/long distance traverses, navigation, remote control, instruments operations, landing systems - procedures, technologies).

- Strong participation to the ESA Aurora Core Programme (architecture studies, MSR preparation studies, and activities related to general exploration technologies and preparation for Lunar exploration).
- Development of a Martian GIS.
- Completion of the 16 Moon studies to develop an Italian vision for Moon Exploration (draft roadmap available).
- Organization jointly with ESA of the 3rd Spineto meeting (May), of the 2nd Conference on Mars Analogues together with CSA (June) and of the 9th ILEWG Conference in Sorrento (October).
- Participation to the GES activities, IMEWG activities (in particular the MSR WG activities).

Upcoming events

2008 will be an important year for Italy, as for the other ESA member states, because of the Ministerial Council scheduled in November where important decisions will be taken for future missions and programmes. Also at national level, new programmes should start once the results of the 2007 AOs issued by the Agency towards the national community will be known. The AOs were three, dealing with small missions, missions of opportunity and new technologies. In this context and in parallel to the continuation of the on-going activities, Italy will focus its attention on the following programmes:

In the ESA framework:

- Aurora: ExoMars (PDR scheduled by mid 2008), NEXT (technology precursor mission of MSR) and the technological studies and R&D activities aiming at preparing MSR.
- Eurobot: a programme of ground testing for robotic systems for orbital and planetary scenarios to which Italy will strongly participate within the framework of Aurora.
- CSTS and related space transportation programmes such as EXPERT (flight test bed designed to provide high quality data on the critical aerothermodynamic phenomena during hypersonic flight) and IBDM (International Berthing and Docking Mechanisms). Other initiatives will be undertaken such as:
  - Development of a Mars Telecom Orbiter to be launched in time for ExoMars TLC and future landed assets on Mars if partners in ESA or outside ESA are available to contribute.
  - Decision will be taken whether or not fly a demonstrator mission for an inflatable module.
  - Decision related to the participation to Hayabusa-2 based on the results of the ASI-JAXA joint study.

Conclusion

Italy is strongly involved in Exploration, both human and robotic. Currently our main objective is the Mars Sample Return mission. At the same time, we are still aiming at enhancing our expertise in the following fields: robotics systems, pressurized modules and life support systems, to acquire new technologies for space transportation with a particular interest for re-entry technologies and to develop new capabilities such as the 70 m Sardinia Ka band antenna for DSN utilization.

BNSC/United Kingdom
Exploration Highlights

Introduction

The main thrust of the UK's exploration activities is through ESA's Aurora Programme. However, the UK is starting to address the wider opportunities presented by the GES by carrying out a review and embarking on detailed discussions with the US. Civil space activities in the UK are coordinated by the British National Space Centre (BNSC), a partnership of government bodies with active involvement in space. The partner responsible for space exploration is the Science and Technology Facilities Council (STFC).

Highlights

During 2007, in addition to its participation in the negotiations surrounding the agreement of the GES Framework for Coordination, the UK has carried out a detailed review of the opportunities presented by the increasing worldwide interest in exploration. The UK Space Exploration Working Group, a team of 23 experts in science, technology, commerce, education and media, considered the issues and made a series of 12 recommendations to BNSC in September 2007 (see http://www.stfc.ac.uk/UKSEWG). These propose an increasing involvement in exploration activities, including the use of both robots and humans.

BNSC has also been working closely with NASA, considering areas of lunar research on which to cooperate. A bilateral joint statement was signed in April 2007 and this led to the setting up of a Joint Working Group on lunar exploration. The final report of this group will be published early in 2008 and identifies possible programmes of joint activity. Possible joint activities could include the Moon Lightweight Interior and Telecoms Experiment (MoonLITE) mission which would see the deployment of a series of penetrators to conduct measurements on the Moon, and the joint development of science and technology needed for mid-term robotic and human exploration activities.

The vision described in the new *UK Civil Space Strategy 2008-2012 and Beyond*, published in February 2008 (see http://www.bnsc.gov.uk), demonstrates an increased commitment to space exploration. The actions it sets out include following up the Space Exploration Working Group report to formulate a programme of activities that can be proposed to government for funding (this is underway and a report is expected around the summer of 2008).

Following the report of the BNSC-NASA Joint Working Group, an international peer-review of the science case will be undertaken. If this is positive, it will then carry out a full mission study to provide a definitive cost estimate.

CNES/France
Exploration Highlights

Introduction

The main contribution of France to the exploration activities is through ESA's programs, mainly ISS and Aurora. However CNES is meanwhile developing complementary activities by providing instruments to the ESA's programs and by supporting the French scientific laboratories.
CNES is also playing a major role in setting up bilateral co operations with the main space faring countries in the framework of its "Multi lateral Program".

Highlights

The main event related to Exploration organised by CNES was the "French Exploration Workshop" which took place in October 2007 in Paris.
Up to that date the main activities of CNES on this topic consisted in internal reflections on potential strategies for France and Europe in the worldwide context. In 2005 CNES went already to the conclusion that Exploration must deal with both robotic and human activities and that a global vision should emerge under the form of "program of programs». Therefore CNES actively contributed to the finalisation of the Global Exploration Strategy by the International Group.
The common GES document has been approved by CNES and presented to the Ministry in charge by May 2007. CNES also endorsed the terms of reference of the ISECG in November 2007.

For the "French Exploration Workshop" about 125 French scientists, engineers from industry and CNES, representatives of education, economy, social sciences and a few politicians convened for three days. They worked in parallel sessions on the same in advance prepared list of items and were invited to propose scenarios by quoting them. Here are the main conclusions:

- Exploration is driven essentially by science and innovation. However, other aspects such as education, public engagement , societal benefits are to be considered also.
- Science cannot just by itself justify Human space missions. The other driving forces for Exploration have to play a role.
- Mars is the most attractive destination and has high scientific value. However mission opportunities on the Moon should not be neglected.
- Europe should engage in a common and shared vision for Exploration
- Exploration is an international endeavour in which each country should be able to contribute in a coordinated manner, according to its own capabilities and its preferred choices
- In view of its sectors of excellence, Europe should engage mainly on robotic missions to Mars with the goal of returning Mars samples to the Earth in the frame of a cooperative program with NASA and others..
- Finally, France and Europe should invest in enabling technologies for Exploration.

Without question, the dominant highlight on Exploration in France was given very recently by the French President during his first speech on the French Space Policy (Kourou 02/11/08). Recognizing the importance of the GES he emphasised the French roadmap for Exploration, namely:

"The fundamental question facing France and its European partners is space exploration. The US has set out an ambitious vision to return to the Moon as a stepping stone to Mars. This vision requires us to make a choice.

This is the most difficult choice and yet the most crucial for our space ambitions. I believe we cannot dispute the desire to extend our presence in the Universe as far as our technological prowess and the courage of pioneers will take us. Asked why he wanted to climb Mount Everest, the mountaineer George Mallory replied: "Because it is there". Because Mars is there and within reach using the technologies now at our disposal, we cannot turn down the chance to embark on this adventure.

Although I am not an astronomer, I suppose that Earth seen from Mars must be barely larger than Mars seen from Earth. To those viewing Earth from distance, national rivalries and playing for prestige will seem trifling in comparison

*Let me be quite clear about this**. I am convinced that space exploration has to be a global effort. It cannot be the sole preserve of any one nation. Each nation will be able to take part with its own capabilities, asset and preferred choices.***

*Europe possesses sectors of excellence in robotic exploration, equipment transport and space technologies that are ready to exploit their talents for the benefit of all. These assets offer Europe the opportunity to play a pivotal role in this vast undertaking. I propose to our partners at ESA and in the European Union that **we should work together to establish the framework for a dialogue with the US and other space powers to structure our efforts**. If we can orchestrate this project to go to Mars, founded on mutual trust and interdependence, it will be real proof that the nations of our planet have reached maturity. **This is an international project**. The US has the financial strength, the engineering and scientific expertise and the political will, and has stated its readiness to proceed with this endeavour. It is certainly not Europe's role to try to imitate it or duplicate its efforts, and even less so to attempt alone in 2010 what the US first accomplished in the 1960s.*

***Europe's role is to offer to form a responsible partnership, leveraging our respective strengths, to build a joint project. And naturally, other space powers with a real engineering and financial contribution to offer, and with a real desire to cooperate, could join the partnership**."*

Speech by the French President Sarkozy, Kourou, February 11. 2008

CSA/Canada
Exploration Highlights

Introduction

During 2007, the CSA participated in the development of the Global Exploration Strategy: The Framework For Coordination. CSA was also involved in the creation of the International Space Exploration Coordination Group (ISECG). In parallel, CSA has established an internal Exploration Steering Committee to review various options for Canadian contributions to the international space exploration effort.

Past significant events and missions in 2007

- CSA has been actively involved in the assembly of ISS with its Canadarm2. This manipulator was critical in most of the assembly tasks.
- CSA contributed the meteorological station for the Mars Phoenix mission launched by NASA in August 2007 and to land on Mars in May 2008.
- In August 2007, Dave Williams was the thirteenth Canadian astronaut in space through his participation to the Space Shuttle Endeavour STS-118 mission.
- In September 2007, CSA issued a RFP to study various concepts to evaluate potential Canadian contributions to space exploration. The studies, were related to be in the areas of:
    - Canadian Moon Mobility System
    - Other potential infrastructure contributions
    - NASA Mars Science Orbiter potential payloads
    - Science instruments for surface operation on the Moon
    - Concepts for exploration sub-systems
    - Medical autonomy
- CSA supported various experiments on the ISS including: research into astronaut cardiovascular and cerebrovascular issues, the study of astronaut perceptual motor deficits in space and an evaluation system to maintain and monitor ISS robotic operator performances.
- CSA continued to support actively the Canadian Analogue Research Network with a special emphasis on Devon Island in the Arctic.
- Good progress in the design of Canada's Alpha Particle Xray Spectrometer for the NASA Mars Science Laboratory mission.

Upcoming events in 2008

- February ESA Columbus launch: includes a Canadian micro-gravity vibration isolation system for science experiments
- March Dextre launch: the last element of the Canadian Contribution to the ISS Mobile Servicing System is added to the ISS. Dextre is a two-arm manipulator capable of performing tasks requiring high precision.
- April: CSA will launch a number of exploration core activities to improve the test infrastructure and start prototyping activities. The objective is to bring potential Canadian technologies and instrument to TRL 5-6.
- May: landing of the NASA Mars Phoenix spacecraft with a Canadian meteorological instrument on board.
- July: CSA will host the second ISECG meeting in Montreal.

- End July: the 18 concept studies contracts on space exploration will be completed. The result of these studies will help CSA in evaluating different options to contribute to the international space exploration activities.

During 2008, CSA will launch a series of studies to evaluate potential Canadian contributions to missions proposed by other space agencies.

CSIRO/Australia
Exploration Highlights

Background

Australia's national science agency the Commonwealth Scientific and Industrial Research Organisation (CSIRO; http://www.csiro.au) represents Australia in the International Space Exploration Coordination Group (ISECG). Australia has played a small but significant role in space science since the earliest days of the space age, when cooperative research with the US in radio communications and tracking led to Australia's management of Australian-based ground stations in support of NASA programs ranging from earth orbiting and human space flight to solar system exploration. CSIRO manages operations of the Canberra Deep Space Communication Complex (CDSCC) in Canberra and the new Australian Tracking Facility (ATF) in Western Australia.

Although few Australian research flight projects have flown in recent years (e.g. WESTPAC/launched 1998; FEDSAT/launched 2002/cooperation with JAXA and NASA), Australia has provided components to a range of international flight projects and is at the forefront of Exploration-relevant technologies such as systems robotics, communications, biomedicine.

Response to the Global Exploration Strategy

Following the May 2007 publication of "The Global Exploration Strategy: The Framework for Cooperation", CSIRO convened an informal, inaugural workshop of government, academic and industrial scientists and engineers on August 21-22 to discuss possible Australian contributions to the Global Exploration Strategy. Based on the group's research and development strengths and the maturity of their areas of technology, on relevance to the national interest, on likelihood of international partnering, and on likelihood of industrial participation we saw two initial areas of focus emerging from the discussion. The first is in the areas of systems engineering, robotics and site characterization. The second area is in radiation damage to DNA and its mitigation. We have initiated dialogue with fellow ISECG members to identify potential opportunities for collaboration in research and flight projects in these areas. Also during this timeframe CSIRO has developed a draft Space Strategy for internal review and the Australian Academy of Science has developed a draft inaugural Decadal Plan for Space Science.

Next Steps in 2008

Australia's path to contributing to ISECG goals lies in international cooperation. Our growing informal working group will reconvene early in 2008. Based on response to our initial report we anticipate that our ad hoc group will continue expanding to include additional relevant activities and technologies even as we continue to pursue avenues for our initial areas of focus. We will pursue these through formal and informal meetings with ISECG members, participation in ISECG meetings and member events, and broadening our industrial outreach both domestically and with CSIRO's international industrial colleagues. Thus 2008 will be a year for furthering existing dialogues and identifying new possible partnerships.

DLR/Germany
Exploration Highlights

In November 2006 DLR held a national Conference on Exploration in Dresden, Germany.

In the course of this event, it became very clear, that the Moon is a challenging topic and that many scientific questions to be answered are still open. Common sense among the participants was that a German Moon-Orbiter-Mission is a promising option. A joint proposal for a Lunar Exploration Orbiter (LEO) was released by the end of January 2007 by leading German science institutes. LEO will orbit the Moon at an altitude of about 50 km. Over a 4 years period our Earth neighbour will be completely mapped (< 1m) with a high resolution multi-spectral stereo camera. Additional innovative instruments will provide data on topography, morphology, mineral composition, regolith structure and abundance as well as on the gravitational and the magnetic field.

The Phase 0 study on LEO as a competitive investigation based on a model payload was contracted to German space industry mid 2007. Study results confirmed the feasibility of the mission. In autumn 2007,the instrument selection process was refined by an announcement of opportunity. A follow-on peer review defined the scientific equipment for LEO.A political decision on the realization of the project is expected within the next months.

Throughout 2007 three other industrial studies had been granted.

The “Mona Lisa” study was completed in May 2007. The study evaluated the national expertise and competence in the various fields related to robotic Moon landing missions. Two reference missions were selected for detailed analysis. Biological habitation on the moon and the necessary H/W was examined as well as concepts for sampling of lunar material at and outside the polar regions.

The study “Lunar Applications & Lander technologies” has looked at technologies for soft precise landing. In particular, lander layouts were analyzed. This led to the definition of preliminary designs, technology needs (involving key technologies) and workable solutions for demonstrators.

The on-going “Scientific and Robotic Lunar Mission” study deals with exploration on the Moon´s surface. The main task of the study is to refine payload demands and mission requirements. A mobile payload will be evaluated especially with respect to mass and mission efficiency by using rovers, crawlers or other robotic devices.

In November 2007 DLR hosted together with ESA the first meeting of the International Space Exploration Coordination Group (ISECG) in Berlin with participation of 12 space agencies. This meeting was held just before the International Space Exploration Conference organized by ESA and DLR. Approximately 400 representatives from space agencies, industries, media as well as politicians and scientists participated in this conference, which emphasized on the European planning steps and the decision content of the next ESA ministerial space conference, in autumn 2008. This conference received great attention in the press and public in Germany.

ESA/Europe
Exploration Highlights

2007 has been a landmark year for ESA and the European participation in the International Space Station with the long awaited installation of the European-built Node 2 'Harmony' and the installation of the European Laboratory 'Columbus' into Shuttle Atlantis (STS-122/1E) ready for launch in early February 2008. European astronauts have contributed to the further assembly of the ISS reinforcing the European role as an active partner in this international endeavour.

The first European automated cargo ATV, dubbed Jules Verne, was shipped to Kourou in French Guyana, where it underwent final testing and integration to ready it for launch atop of an Ariane 5 rocket. The ATV will serve as supply ship to the ISS, increasing significantly the supply capability towards the Station.

During the year 2007 key milestones were completed for the European exobiology robotic mission to Mars, ExoMars, and the mission is progressing well towards the scheduled launch date of 2013. An enhanced mission configuration was decided during the course of 2007 that will make the mission more robust and will accommodate more scientific payload. The required additional funding will be secured at the end of 2008.

European exploration scenarios were elaborated in consultation with the European stakeholders through several thematic workshops in the UK, Italy and Germany, including the 3rd ESA/ASI Workshop on International Cooperation for Sustainable Space Exploration. Moon and Mars architecture studies were carried out in a series of parallel industrial studies. A Phase A study for a Mars Sample Return mission was continued and provided, among other things, inputs to the definition of MSR precursor missions. These precursor mission concepts target both the Moon and Mars. A final decision as to whether and which precursor mission will be carried out is due at the end of 2008. In the meantime ESA has played a proactive role in the establishment and activities of an International Mars Architecture for the Return of Sample (IMARS) subgroup under the IMEWG. Aim of this subgroup is to develop a common understanding of an international Mars Sample Return mission to be carried out towards 2020.

Development activities for generic exploration technologies continued throughout 2007 and included work on habitation modules (e.g.SpaceHaven) and life support systems.

As far as robotic missions are concerned Mars Express, that has been orbiting Mars since December 2003, continued its successful gathering of data while Venus Express is being operated in the orbit of Venus since April 2006 and Rosetta continues its journey to its target comet.

Mission proposals were submitted in response to the call initiating the first planning cycle of the Cosmic Vision 2015-2025 long-term plan. The Call produced a broad list of mission proposals among which a mission to Saturn, one to Jupiter and one NEO sample return were retained for further studies before the next down selection to 1 mission, with an expected launch date in 2017 or 2018.

Upcoming significant events

Launch of Columbus with 2 European astronauts, of which one will stay on board ISS for a full increment and will initiate research activities after on orbit activation and verification

Launch of the first ATV, which will bring cargo to ISS and also reboost the station

Council at Ministerial level in November 2008 which will decide on major programmes for the next 3 years, including exploration

JAXA-JSPEC/Japan
Exploration Highlights

The year of 2007 was the most memorable year for JAXA on the space exploration. The Selenological and Engineering Explorer (SELENE), nicknamed “KAGUYA” was launched from JAXA’s Tanegashima Space Center by the H-IIA launch vehicle flight 13th in September 14th. The major objectives of the KAGUYA mission are to obtain scientific data of the lunar origin and evolution and to develop the technology for the future lunar exploration. KAGUYA consists of a main orbiting satellite at about 100km altitude and two small satellites (Relay Satellite and VRAD Satellite) in polar orbit. The orbiters carry fourteen instruments for scientific investigation of the Moon, on the Moon, and from the Moon as well as the HDTV.

The Earth-set from near south pole of the Moon taken by Kaguya’s onboard HDTV camera

The operation mode of the KAGUYA was shifted to regular operations from its initial verification on December 21st as we were able to acquire satisfactory verification results for all fifteen observation missions.

In March 7th-9th, JAXA was pleased to host the Kyoto Workshop for Global Space Exploration Strategy with fourteen space organizations. During this workshop, we agreed common understanding of a shared view of space exploration which reflects each organisation's interests and priorities. This concept was elaborated in the document entitled "Global Exploration Strategy: A Framework for Coordination". Simultaneously, as the outreach and the promotion activities for national public and stakeholders, we held the Space Exploration Symposium with national and international speakers to review past effort and to perspect future space exploration activities. Soon after the succesful two events, in April 1st, JAXA was established new branch for space exploration activities which is called JAXA’s Space Exploration Center (JSPEC). The core task of the JSPEC are both robotics and human lunar and other planetary exploration activities.

In 2008, JAXA/JSPEC will conduct SELENE-2 and Hayabusa follow-ons (Hayabusa-2 and Marco Polo) phase A studies. SELENE-2 is the mission which consists of the lunar lander and rover to establish soft-landing technology and in-situ detail observation on lunar surface. Hayabusa follow-ons are the exploration of the different types of primitive bodies to solve the origin of the solar system and to establish sumple return technology. JAXA/JSPEC is conducting these missions with international cooperation. The first International Primitive body Exploration Working Group (IPEWG) meeting (was/is) held in Okinawa, Japan in January to aim international coordination acting on the ISECG’s mind. Regarding human space activities, which is also our interest, we are currently focusing on the International Space Station (ISS) program. In 2008, the first two elements of Japanese Experiment Module (JEM) nicknamed “KIBO” (hope) will be launched by two Space Shuttle launches. Japanese astronauts will fly for the construction as well as the expedition mission in the ISS. New technology development and strategic study for the next human space activities such as human lunar exploration are also underway.

NASA/United States of America
Exploration Highlights

Human Spaceflight: After launching three successful space shuttle missions in June, August and October, the International Space Station in 2007 grew in size, volume and power production. NASA astronauts and Russian cosmonauts conducted 22 spacewalks, matching a record for the most spacewalks in a single year.

Robotic Exploration: NASA's **Phoenix** mission launched August 4 with a scheduled arrival at the Red Planet May 25, 2008. Phoenix will utilize its robotic arm to investigate whether the subsurface environment in the far-northern plains of Mars ever has been favorable for sustaining microbial life. NASA's **Dawn** spacecraft launched September 27 on 1.7-billion mile journey through the inner solar system. Utilizing a revolutionary hyper-efficient system called ion propulsion to generate thrust, Dawn will study a pair of asteroids -- Vesta in 2011 and Ceres in 2015. Integration and testing progressed for the **Lunar Reconnaissance Orbiter (LRO)**, which, following launch along with the **Lunar Crater Observation and Sensing Satellite (LCROSS)** aboard an Atlas V scheduled for late 2008, will spend at least a year mapping the surface of the moon. Data from LRO and LCROSS will help NASA select safe landing sites for astronauts, identify lunar resources and study how the moon's environment will affect humans. Finally, in December NASA announced the selection of the **Gravity Recovery and Interior Laboratory (GRAIL)** as part of NASA's Discovery Program. Scheduled to launch in 2011, GRAIL will fly twin spacecraft in tandem orbits around the moon for several months to measure its gravity field in unprecedented detail.

Human Exploration: Progress continued throughout 2007 on project Constellation -- the system that will eventually be used to return humans to the lunar surface before 2020. Construction began on the site where NASA will hold Constellation's first flight tests in early 2009. NASA's Lunar Lander Project Office also began developing conceptual designs and seeking industry input for the "Altair" lunar lander. Altair will eventually be capable of landing four astronauts on the moon, providing life support and a base for weeklong initial surface exploration missions and returning the crew to the Orion spacecraft that will bring them home to Earth. Further details were also unveiled regarding NASA's plans for an "open architecture" lunar outpost – one that maximizes opportunities for international participation. NASA's Lunar Architecture Team (LAT-2) study produced more details of NASA plans for a lunar outpost complete with small, pressurized rovers that would travel in pairs, and possible astronaut housing that could be moved from one location to another.