The 2008 Annual Report

of the

International Space Exploration Coordination Group

Released March 2009

THIS PAGE INTENTIONALLY BLANK

CONTENTS

THIS PAGE INTENTIONALLY BLANK

International Space Exploration Coordination Group
Annual Report: 2008

Introduction

This second Annual Report of the *International Space Exploration Coordination Group* (ISECG) and its sub-working groups provides highlights of their activities during the past twelve-months including the progress of its Workplan, work ahead, the major space exploration accomplishments of its members including future opportunities, and progress in implementing the Themes described in *The Global Exploration Strategy: The Framework for Coordination*.

In addition, this ISECG Annual Report, as with the 2007 edition, provides an opportunity for agencies to update the international community on their individual space exploration plans – this information will be found in the Annex.

The Annual Report is intended to keep all exploration stakeholders, including other exploration related coordination groups, better informed of the ISECG's work and progress implementing the Global Exploration Strategy Framework document.

Efficient, beneficial and public supported Space Exploration can only be accomplished as an international endeavour involving a diverse stakeholder community comprising; space agencies and their policy/funding governments, industry, scientific institutions, academia, and non-profit groups. The ISECG is facilitating this dialogue and understanding.

THIS PAGE INTENTIONALLY BLANK

Part 1
The Role of the ISECG

1.1 Overview

The *International Space Exploration Coordination Group* (ISECG) was born out of *The Global Exploration Strategy: The Framework for Coordination* (GES or Framework Document) that was prepared by fourteen space agencies[1] and published in May 2007. The GES elaborates a vision for the peaceful robotic and human space exploration, including a common set of key space exploration themes, focusing on destinations within the Solar System where humans may one day live and work. This focus on human activity puts low-Earth orbit, the Moon, and Mars into particular focus of the ISECG. The Framework Document also established the framework for the creation of the ISECG.

The GES/Framework Document was clear concerning the Principles and Resulting Requirements that would govern the ISECG. The guiding Principles are:

- Open and Inclusive (open to any agency with a vested interest in space exploration)
- Flexible and Evolutionary (to meet changing needs and circumstances)
- Effective (work to an agreed Work-Plan with deliverables useful to all stakeholders)
- Mutual Interest (meet the needs of all stakeholders)

The Terms of Reference (TORs) for the ISECG were formally adopted at the first meeting of the ISECG held in Berlin in November 2007. The primary purpose of the ISECG is to provide a forum for space agencies to discuss their interests, objectives and plans in space exploration with the view to working collectively towards the further development and implementation of the entire scope of the Global Exploration Strategy set out in the Framework Document. The expected benefits of this coordination are to increase robustness, safety and cost effectiveness of individual and collective exploration goals, and to facilitate the ability of participating agencies to engage in productive bilateral or multilateral discussions, while preserving their autonomy. This will contribute to strengthening the sustainability of global space exploration. In addition the ISECG will strive to promote interest and engagement in space exploration activities throughout society worldwide.

The scope of the ISECG activities are broad and strategic, and focused on developing non-binding findings, recommendations and other outputs as necessary for use by participating agencies. In this regard the ISECG is different from other similar groups. The latter, such as the International Mars Exploration Working Group, having a more destination or discipline focus. Importantly, it is not the intent of the ISECG to either duplicate the work or govern the work of other coordination groups, but rather to "work with" them to ensure that ISECG Workplan activities are being covered.

[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.

From the outset it was agreed that the ISECG would perform its work through an agreed Workplan with each activity being undertaken by a working-group comprising members with a particular interest and expertise in the subject. The Workplan is updated periodically as required such that it is always current, i.e., it is not an annual Workplan. Each Working-Group has a concrete deliverable(s). The ISECG and its Working Groups meet regularly via teleconference, as well as face-to-face meetings, and the ISECG meets in Plenary at least once a year. During the Plenary session agencies share the latest developments in their exploration programs and review the progress of the Workplan Working Groups. The ISECG is supported by a small permanent Secretariat, provided by ESA.

The second meeting of the ISECG was held in Montreal, Canada in July 2008 and the third meeting was held in Yokohama, Japan in March 2009.

For more information on the ISECG, its publications and for Agencies to request membership please contact the ISECG Secretariat at: Raffaella.Pappalardo@esa.int. The ISECG will soon have a dedicated website.

1.2 Working Groups of the ISECG

The ISECG accomplishes its tasks throughout the year through the work of several working groups. These working groups are introduced below, and in some cases described in more detail in corresponding sections of this report.

1.2.1 Enhancement of Public Engagement

This Working Group, led by DLR, is identifying the key elements for public engagement that could be used by participating Agencies to promote exploration.

1.2.2 Establishment of Working Relationships with Existing International Working Groups

As already mentioned it is not the intent of the ISECG to either duplicate the work or govern the work of other coordination groups, but rather to work with them to ensure that ISECG Workplan activities are being covered. This Working Group, led by CNES, has identified those international bodies of particular relevance to the ISECG and is ensuring that these groups are familiar with the work of the ISECG – the ISECG Annual Reports are one informing mechanism.

In addition the ISECG has identified areas, which would greatly benefit from close contact between ISECG and existing working groups. Examples of such activities include:

(a) development of exploration data archiving and distribution standards as might be addressed by the International Planetary Data Alliance,
(b) development of standards to support space exploration communications interoperability as are being addressed among those agencies actively planning spacecraft beyond Low Earth Orbit, the Space Frequency Coordination Group, the Interagency Operations Advisory Group and the Consultative Committee on Space Data Systems,

(c) development of a common Lunar cartographic reference system as might be undertaken by the International Lunar Exploration Working Group, the International Astronomical Union (IAU)/IAG Cartographic Working Group and the International Planetary Data Alliance (IPDA).

1.2.3 The International Space Exploration Coordination Tool (INTERSECT)

The development of INTERSECT is led by CSA and ESA, and it will serve the ISECG members as web-based/interactive data base. Its purpose, when fully developed and maintained, is to provide a single reference source for ISECG members. This is further described in the beginning of Part 3.

1.2.4 The Space Exploration Interface Standards Working Group (ISWG)

This Working Group, led by NASA, is identifying the key exploration element interfaces recommended to be common, and of priority, that would maximize opportunities for international cooperation in an open architecture environment. The work of this Working Group is further described in Section 3.3.

1.2.5 Mapping the Space Exploration Journey

A human mission to Mars is surely a long-term objective in our collective future. However, there is a great deal of work that lies ahead before the community of space explorers could execute such a mission. In 2008, Germany (i.e. DLR) proposed the ISECG accept a task related to Chapter 3 of the Framework Document, "Mapping the Space Exploration Journey." The objective of this new ISECG task, Mapping the Barriers to Robotic and Human Exploration, would be to identify the significant, known technological and operational challenges associated with extending human presence to various destinations in the Solar System.

THIS PAGE INTENTIONALLY BLANK

Part 2
Current and Near-Term Activities of ISECG Members

The year 2008 saw a great deal of activity in all areas of space exploration. Spacecraft that recently arrived at the Moon continued their investigations of the Earth's natural satellite, and spacecraft at Mars continued unabated on their course of exploration that has been ongoing for several years. Also, in 2008 plans were solidified for new missions in the solar system, and, importantly for the ISECG, exploration in the near-Earth neighborhood.

2.1 Low Earth Orbit (LEO)

2.1.1 The International Space Station (ISS)

This past year, 2008, was a milestone year for the ISS. It marked the 10th anniversary of on-orbit operations, Zarya, a Russian built U.S. control module, was the station's first component. NASA completed four space shuttle missions, which included the, much awaited, launch of the European Columbus and Japanese Kibo laboratories and the Dextre two-armed robot, the final element of Canada's robotics contribution. Europe accomplished a highly successful six-month maiden mission of its first Automated Transfer Vehicle Jules Verne to the ISS. Also, with the activation of the Japanese and European elements 2008 marked the beginning of new fully operational spaceflight control centers in Germany, France and Japan that are working closely with existing control centers in the U.S., Russia and Canada. These flights also prepared the station to house six-crew members beginning in 2009 and for the arrival of Kibo's attached un-pressurized exposed facility (for external scientific payloads).

In the decade since Zarya arrived in orbit, the station has grown to become the largest spacecraft ever built. Its mass has expanded to more than 313 tons, and its interior volume is more than 25,000 cubic feet/708 cubic meters. The station now hosts 19 research facilities, including nine sponsored by NASA, eight by European Space Agency and two by Japan Aerospace Exploration Agency. Fully utilizing the International Space Station is now a primary goal of all the ISS partners.

2.1.2 Emerging Government Capabilities

China has become only the third nation to have an autonomous human space flight capability. Their 3rd mission in October 2008 moved them one step closer to a full capability with a successful mission that included an extra vehicular activity with a Chinese EVA suit.

The NASA Constellation program comprises all vehicles and systems that will form the next generation U.S. crew and cargo transportation system for human space exploration. The initial elements of the Constellation Transportation Architecture are the Ares I crew launch vehicle and the Orion crew exploration vehicle. The Orion will replace the Shuttle for the transportation of four to six crew and small payloads to the ISS beginning in 2015. The Ares-I achieved a major milestone in 2008 with a successful Preliminary Design Review.

2.1.3 Emerging Commercial Providers

In recent years a new industry has been added to the lexicon of industries. Referred to as *New Space*, this industry is currently dominated by entrepreneurial firms with a focus on Space Tourism and commercial transportation services to LEO for government customers.

A leader in the entrepreneurial area is Virgin Galactic – a partnership between the firm Scaled Composites and Richard Branson's Virgin Group. Scaled Composites was the winner of the Ansari X-Prize, demonstrating the ability to launch and return a human into suborbital flight twice within two weeks with the same launch system. Scaled Composites is now building WhiteKnight Two and SpaceShipTwo as part of the Virgin Galactic enterprise; SpaceShip Two will be capable of taking six paying passengers into space. Other players in the space tourism business include Space Adventures, perhaps the first space tourism company, who broker short duration missions for paying customers (four to date at approximately $30m each) to the ISS on Russian Soyuz vehicles; and Bigelow Aerospace, which is developing inflatable Earth orbiting habitats that may one day be available as a space tourist destination. Thus far Bigelow Aerospace has successfully deployed two engineering prototypes.

The California-based SpaceX, is developing a family of new, low-cost launchers. The fourth launch of their first vehicle, the Falcon 1, in September 2008 was a success. SpaceX and Orbital Sciences Corporation are both participants in the NASA Commercial Orbital Transportation Services (COTS) program – NASA is awarding a total of $500 million between the two companies for the successful demonstration of cargo transportation capabilities to LEO. At the end of 2008 NASA awarded contracts to both SpaceX and Orbital for commercial cargo services to the ISS.

Another X-Prize that is encouraging the development of commercial activities on the Moon is the Google-Lunar X-Prize that will award a total of US$30m to the team(s) that can land a rover on the Moon and transmit data back to Earth.

2.2 Beyond LEO – The Moon and Mars

2.2.1 Moon

Lunar scientific exploration will involve three types of investigations: science 'of the Moon', science 'from the Moon', and science 'on the Moon'. Science 'of the Moon,' which involves lunar geology, geochemistry and geophysics, will help us understand the history of the Moon. The Moon is an invaluable witness to much of solar system history. It has recorded this history more completely and more clearly than any other planetary body. During 2008 three spacecraft were orbiting the Moon carrying out a variety of measurements. These are Japan's Selene-1 (or Kaguya), China's Chang'e - 1, and India's Chandrayaan-1. China's Chang'e-1 completed its mission in February 2009.
Launched in September 2007, Kaguya includes the most comprehensive suite of instruments yet sent to study the Moon, a total of fifteen instruments on three total spacecraft:a main orbiting satellite at about 100km altitude and two small data relay satellites in polar orbit. The Kaguya High Definition Television (HDTV) captured on video for the first time a full Earth Rise over the

Moon – an image that will undoubtedly be the 21st Century's equivalent of the Apollo "Earth-rise" still photograph. Launched in October, 2007 Chang'e 1 is China's first planetary probe to the Moon. And launched in October, 2008 Chandrayaan-1 is a complex spacecraft with eleven instruments including instruments from Europe (ESA), United States (NASA) and Bulgaria.

Though they have their own individual mission goals and designs, there are notable overlaps in their objectives. These overlaps include the collection of high-resolution data to create a chemical and mineralogical map of the Moon's interior, search for sub-surface water at the lunar poles, and to develop a high resolution three-dimensional topographical map of the lunar surface on both the near and far sides. By searching for elements like Magnesium, Aluminium, Silicon, Calcium, Iron, and Titanium while creating a detailed map of the lunar surface scientists can answer questions about the Moon's origin and geological evolution and how that relates to the evolution of the Earth.

In 2009 (schedule is April) NASA will launch its Lunar Reconnaissance Orbiter (LRO) with a surface impactor, the Lunar Crater Observation and Sensing Satellite (LCROSS). These spacecraft will join their international counterparts mapping and characterizing the lunar surface and geological structure. Following LRO from NASA will be the Gravity Recovery and Interior Laboratory (GRAIL) and the Lunar Atmosphere and Dust Environment Explorer (LADEE), both planned for 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, and LADEE will orbit the Moon whose main objective is to characterize the atmosphere and lunar dust environment.

The creation of detailed maps of the lunar surface and subsurface is necessary to enable a second phase of lunar exploration to take place in the next decade. Japan, India, and China will all be sending landing spacecraft to the Moon, all likely to include a rover, to do further studies of lunar regolith and to characterize the environment of the Moon at its location in inner solar system. Selene II, Chandrayaan II, and Chang'e 2 will join LADEE and GRAIL in the next decade to make the Moon the most internationally visited location in the solar system. The scientific investigations of the orbiters currently at the Moon will provide information about where to send a lander to maximize the return on its scientific endeavors; the detailed maps they will help identify specific, safe landing locations for those landers. For NASA in particular a detailed map of the lunar surface will help identify safe landing locations for the Altair lunar lander (one of the elements of NASA's Constellation program i.e. the next generation crew and cargo vehicles).

2.2.2 Mars

Mars is a key focus for space exploration because the planet is relatively close and it has resources that may aid human exploration, an atmosphere, diverse minerals, and water. Better knowledge of Mars would help us understand Earth's history and evolution. The scientific exploration of Mars is motivated by the search for life; in the past or present. Did life ever exist on Mars? Will Mars be able to support human life and exploration in the future? These are the questions that drive Mars exploration with current investigations centered around Martian climate and geology. While there is no clear evidence of liquid water on the surface of Mars today, the record of past water activity can be found in the rocks, minerals, and geologic

landforms. Spacecraft at Mars map mineralogical and geomorphological features, providing clues to environmental conditions, and delineating sites evincing interaction with liquid water, which may have been conducive to life.

There are currently five spacecraft exploring Mars, three from orbit and two on the surface. In orbit are the U.S. Mars Odyssey (launched in 2001), ESA's Mars Express (launched in 2003), and the U.S. Mars Reconnaissance Orbiter (launched in 2005). In addition, since January 2004 two US rovers (Spirit and Opportunity) have been roving on Mars. The rovers were joined on the Martian surface in May 2008 by the U.S. Mars Phoenix lander, which performed superbly until the onset of the polar winter.

Mars Odyssey was the first mission to map the elemental composition and minerals of the near surface. The Mars Reconnaissance Orbiter has been successfully providing high-resolution spectral images of the Martian crust, mapping the distribution of minerals seen in the near infrared, and creating planetary-scale maps of critical atmospheric properties. Mars Express has been exploring the interior, surface, and atmosphere of Mars. It as produced high-resolution images, ionosphere and sub-surface sounding measurements, detection of methane, mineralogical data and information concerning the composition of the icecaps. The Mars Exploration Rovers Spirit and Opportunity offer unique contributions as roving robotic geologists in pursuit of the science strategy to "Follow the Water." For 5 years they have travelled the surface of Mars for more than 10km each, collecting samples of soil and finding clues to past water activity on Mars. The complement of the Phoenix spacecraft (which completed its mission near the end of 2008) and its scientific instruments were ideally suited to uncover clues to the geologic history and biological potential of the Martian arctic. Phoenix was the first mission to return data from either polar region. It used a robotic arm to dig through the protective topsoil layer to the water ice below and ultimately, to bring both soil and water ice to the lander platform for sophisticated scientific analysis.

These spacecraft have effectively investigated the whole planet, and scientists have made significant discoveries. They have found sub-surface water and water ice at the poles, evidence of surface water and ground water interactions in the equatorial latitudes, and gases like methane in the atmosphere. Ground observations of methane show it to vary in time and space – requiring an active source and rapid removal mechanism. This variablity suggests that the planet is still alive, at least in a geologic sense, and that perhaps the biological processes of microbial life are responsible for the release of the methane. If microscopic Martian life is producing the methane, it likely resides far below the surface, where it is still warm enough for liquid water to exist.

In the next decade there will be several more missions that will continue the scientific exploration of Mars. There are currently two U.S. missions in development. First is the Mars Science Laboratory, planned for launch is 2011. The Mars Science Laboratory will use a long-duration rover and 10 payload elements for definitive mineralogical and organics measurements, assessing the habitability of Mars for past or present life. Second is a Scout-class (small <$500m) mission called MAVEN, an orbiter that will provide information about the current state and processing affecting the composition of the atmosphere and its evolution through time. It is scheduled to launch in 2013.

In 2016 ESA plans to launch its ambitious ExoMars mission. ExoMars science objectives are to search for evidence of past or present life, characterize the water/geochemical environment including the collection of samples down to a depth of 2 meters, identify potential hazards to future human exploration, and investigate the subsurface and deep interior to better understand the planet's evolution and habitability. It will be the first European mission to demonstrate advanced technologies for Entry, Descent and Landing, and will be the first European mission to employ a surface rover, as well as a Drill and Sample Preparation and Distribution System.

The first joint Chinese-Russian mission to the Martian Moon Phobos is set to launch in October 2009. It should reach the red planet in August 2010. A Russian Zenit rocket will launch a Chinese Yinghuo-1 satellite and a Russian Phobos-Grunt lander. Phobos-Grunt is expected to study Mars from orbit, including its atmosphere and dust storms, plasma and radiation, before landing on Phobos The mission’s objectives are to collect soil samples from Phobos, and to bring the samples back to Earth for comprehensive scientific research. Rososmos and ESA agreed to use the communications payload onboard of Phobos-Grunt to support the ExoMars mission. In return ESA, agreed to provide its ground control network for telemetry, tracking and flight control needs of the Phobos-Grunt mission. ESA also helped to plan the Phobos-Grunt mission. The Mars Express camera took high-resolution images of the potential landing sites on Phobos.

THIS PAGE INTENTIONALLY BLANK

Part 3
Progress in 2008 towards Opportunities for Integrated and Collaborative Space Exploration

Part 2 offered a brief overview and summary of current and near-term exploration missions built and launched by individual space agencies. While each mission may have instruments or components provided by international partners, like NASA instruments on India's Chandrayaan I, each can legitimately be thought of as a *national* mission. Cooperation on national missions and cooperation in fully integrated or shared missions will be enhanced with the utilization of the ISECG's International Space Exploration Coordination Tool (INTERSECT). INTERSECT will provide integrated and validated information on international space exploration plans, associated exploration capabilities and systems, and related agencies exploration goals. INTERSECT will greatly enhance agencies' ability to identify areas for cooperation, and help inform their own national space exploration architectures to ensure the sum of the whole is greater than the individual parts. In sum, INTERSECT will facilitate communication among agencies to identify more collaborative and integrated exploration efforts.

With respect to robotic missions, two types of such collaborative exploration are under discussion: network science missions, and integrated joint development missions. Human exploration of the Moon also creates an opportunity for integrated international exploration. In 2008 significant progress was made in these areas, and though it is early progress it is the necessary foundation for eventual mission success.

3.1 Robotic Network Science – The International Lunar Network

In March 2008 NASA proposed the concept of the International Lunar Network (ILN) to the international community at the Lunar and Planetary Science Conference. Investigations, which require multiple, simultaneous measurements from more than one surface site are referred to as *network science*. The ILN aims to provide an organizing theme for all landed science missions in the 2010s by involving each landed station as a node in a geophysical network.

In the ILN concept, each node would include some number of "core" capabilities or sensors e.g., seismic, heat flow, laser retro-reflectors. Individual nodes could and likely would carry additional, unique experiments to study local or global lunar science. Such experiments might include atmospheric and dust instruments, plasma physics investigations, astronomical instruments, electromagnetic profiling of lunar regolith and crust, local geochemistry, and in situ resource utilization demonstrations.

Since March several ISECG agency members have been participating in ILN Working Group discussions to define the network's core measurements, enabling technologies, and communications requirements to ensure the inclusion of nodes on the far side of the Moon. On July 24, 2008 a meeting of the space agencies of Canada, France, Germany, India, Italy, Japan, the Republic of Korea, the United Kingdom, and the United States was held at NASA's Lunar Science Institute, located at the Ames Research Center. During the meeting, the representatives of the nine space agencies, mentioned above, discussed cooperation on ILN and agreed on a statement of intent as a first step in planning.

If the ILN is successful it will demonstrate the feasibility of network science for the geological study of Mars.

3.2 Joint Development for Robotic Exploration – Mars Sample Return

A Mars Sample Return (MSR) mission has been at the top of many international priority lists for Mars science. In 1993, the international community established the International Mars Exploration Working Group (IMEWG) to provide a forum for the coordination of Mars exploration and develop an international strategy. It has long been recognized that a MSR mission would be so complex as to have high development costs and high implementation risks. In order for such a mission to be feasible, it would be necessary to share the costs and risks among multiple international partners. In May 2006 IMEWG chartered a specific working group to examine the feasibility of an international MSR mission. This working group began its efforts in September 2007 under the name iMARS – international Mars Architecture for the Return of Samples.

The iMARS working group released a Phase 1 report in June 2008 that among other topics summarized international mission architecture options and identified technology development milestones to accomplish a multinational MSR mission. The report in full is titled "Preliminary Planning for an International Mars Sample Return Mission: Report of the iMARS Working Group," and can be found at the following website: http://mepag.jpl.nasa.gov/reports/index.html#IMEWG. The iMARS team had thirty-one participants from ten different countries[2] broken into three sub-teams focusing on engineering requirements, science objectives, and facilities needs for the study of returned samples. The team analyzed five mission architecture scenarios and produced a reference architecture approach that includes two elements launched separately: one carrying an orbiter that includes the Earth return system and one with the landed components including a sample-acquisition rover and the Mars ascent vehicle that launches the sample from Mars' surface. The reference architecture also includes recovery and containment after Earth entry and one or more Sample Receiving Facilities.

One benefit of the iMARS effort is that it sheds light on the many difficult questions that have to be answered in carrying out a truly integrated international mission, questions beyond the technical issues of where to land on Mars and what samples to collect. Questions having to do with program management protocols, funding mechanisms, task allocation for each piece of the mission architecture, and science oversight are all subject to inquiry. The development of the reference architecture for MSR was only step one in a multistep process for IMEWG and iMARS, but if there is ever to be a successful MSR mission then this first step, taken together by an international community, may prove to be the most important.

[2] Australia, Belgium, Canada, France, Italy, Japan, Sweden, Switzerland, United Kingdom, United States plus the European Space Agency.

3.3 Collaborative Human Exploration of the Moon

Described briefly in Section 2.1.2 the NASA Constellation Program is leading the development of a new fleet of U.S. transportation vehicles to enable space exploration beyond LEO. In addition to the Ares I and Orion vehicles, already mentioned, NASA is developing the Ares V cargo launch vehicle and the Altair lunar lander. Together, these vehicles will all be used to transport human crews to the Moon no later than 2020, and will be part of missions to explore beyond in coming decades.

NASA completed its first important milestone for lunar exploration, a Lunar Capability Concept Review (LCCR) in June 2008. The three-day LCCR capped a nine-month study that looked at possible lunar mission scenarios and compared them to the capabilities of the Ares V and Altair. The review refined early configurations of the Ares V rocket to ensure its capability to deliver the Altair lunar lander, four astronauts and cargo anywhere on the Moon and return the crew to Earth at any time. The Ares V will be able to send more than 156,600 pounds/71,000 kilograms of cargo and components into orbit to the Moon. Altair will be capable of landing four astronauts anywhere on the Moon, providing life support for the first weeklong surface exploration missions. A variant of the lunar lander will serve as an autonomous cargo carrier, taking modular outpost components, lunar rovers, and scientific equipment to the Moon's surface.

These NASA provided transportation elements cannot comprise the full suite of systems operating on the Moon if human lunar exploration is to have a sustainable future. To sustain human presence beyond Earth, we should learn from science ‘on the Moon’ how to live and work on other celestial bodies. To do so will take time and experience, and much like the MSR mission there will be significant cost and risk, almost requiring international collaboration as a result. Recognizing this fact NASA worked with ISECG members to create in early 2008 the space exploration International Standards Working Group (ISWG) introduced in paragraph 1.2.4. This working group will first take on the task of identifying the key exploration element interfaces recommended to be common, and of priority, that would maximize opportunities for international cooperation in an open architecture environment.

In order to identify these interfaces, the ISWG is preparing a number of lunar surface exploration scenarios and associated surface elements for transportation, habitation, and scientific investigations. It will be the forward work of the ISECG participants to add to the tasks of the ISWG an agreed to slate of science objectives to be accomplished via a human presence at the Moon, and, to identify the best way for human activity at the Moon to inform preparation for an eventual human mission to Mars. Building on this work, the ISWG in 2009 will outline, an international surface exploration reference architecture and begin to identify what all the various ISECG members can contribute to the long-term human exploration of the Moon. This will be about a two-year effort, and in keeping with the general timeline when agencies will have completed their conceptual studies for a Lunar Surface Architecture.

3.4 An Eventual Human Mission to Mars

For several years NASA and ESA have independently examined the complexities of a human mission to Mars and have identified many of the technical barriers that currently exist. In 2008 ESA presented several of its conclusions about the requirements for a human mission to Mars at its Exploration Conference in July, and NASA finalized its Mars Design Reference Architecture 5.0. A brief review of either agency's work would show that the primary source of humans-to-Mars challenges is the time requirement, with missions lasting in excess of 500 days and transportation to and from Mars taking approximately 180 days each way. The challenges that fall out of such a mission profile can fall into at least five categories, including transportation and propulsion, power and thermal, habitation, human protection, and technology development.

Much can be learned in these areas by utilizing the Moon as a proving ground. As was stated in the Framework Document, *The Moon, as our closest 'natural space station,' is the ideal place for humanity to develop the capability to journey to Mars and beyond.* Consider the need to provide for a safe and effective long-duration mission with exposure to the Mars radiation and solitary environment. A successful human mission to Mars will require the long-duration performance of countermeasure equipment and protocols, medical diagnosis and treatment equipment, and long-term food storage. As a proving ground, the Moon can validate the efficacy and performance of countermeasure equipment, validate and demonstrate medical equipment, and validate food systems and habitat human factors.

It is the forward work of the ISECG to use much of the work carried out by individual agencies or small groups of agencies as a foundation for more collaborative roadmapping of the way forward in space exploration. Such a roadmap would identify the kinds of challenges described above and identify scenarios by which an international community can meet these challenges. The first version of INTERSECT and an interim report from the ISWG will be the foundation of such a long-term roadmap.

Part 4
Summary and Way Forward

The Global Exploration Strategy: The Framework for Coordination published in 2007 articulated the following Themes for the international exploration of space:

- New Knowledge in Science and Technology
- A Sustained Presence – Extending Human Frontiers
- Economic Expansion
- A Global Partnership
- Inspiration and Education

The ISECG Annual Report 2008 shows that much progress has been achieved in all these themes by space Agencies, individually, through collaborative activities and collectively facilitated by existing international groups, including the ISECG.

New Knowledge in Science and Technology
New knowledge derived from lunar and Mars missions (see paras 2.2.1 and 2.2.2) • Chandrayaan orbiter mission • Kaguya orbiter mission (see also JAXA Exploration Highlights in Annex) • Chang'e 1 orbiter mission • Several Mars orbiting and landed missions including Phoenix in 2008 (see also NASA Exploration Highlights in Annex) New capabilities developed for human exploration (see para 2.1.2) • 1st successful flight of ATV mission to ISS (see ESA Exploration Highlight in Annex) • Attachment of Columbus laboratory to ISS (see ESA Exploration Highlight in Annex) • EVA capability demonstrated during 3rd Shenzhou mission • PDR of ARES I successfully completed (see NASA Exploration Highlights Highlight in Annex)

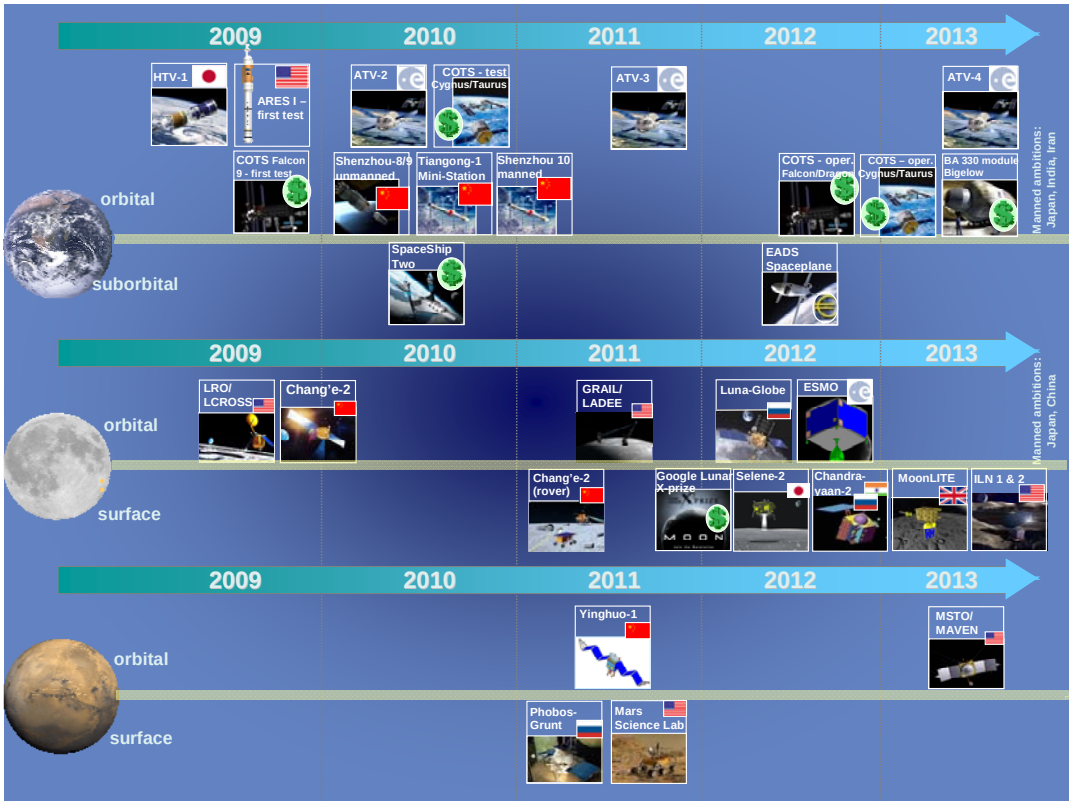
A Sustained Presence – Extending Human Frontiers
10th year of on orbit operations onboard ISS (see para 2.1.1)

Economic Expansion
Emerging commercial capability providers (see para 2.1.3): • Demonstration of commercial suborbital transportation capabilities by Virgin Galactic/Scaled Composites • Successful launch of Falcon 1launcher by Space X • Successful deployment of prototype inflatable habitats by Bigelow Aerospace

A Global Partnership
• Development of prototype of International Space Exploration Coordination Tool (INTERSECT) for information exchange on planned missions and capability developments by the ISECG (see para 1.2.3) • Initiation of International Lunar Network (ILN) initiative by NASA (see para 3.1) • Development of a reference architecture for Mars Sample Return mission by iMARS working group which is subordinated to the IMEWG (see para 3.2) • Initiation of work on an international reference architecture supporting human missions to Moon by the Interface Standards Working Group which is subordinated to the ISECG (see para 3.3)

Inspiration and Education
Initiation of a working group for coordination of public engagement activities by ISECG (see para 1.2.1)

The future exploration plans of space Agencies demonstrate a shared ambition to further progress in the implementation of the Global Exploration Strategy. ISECG will continue to provide a platform for early information exchange between these Agencies for coordinating plans and identifying opportunities for international cooperation.



ISECG will specifically address the following objectives throughout 2009:

- Better understand global exploration objectives and means of achieving these objectives through collaboration;

- Finalize the development of a tool for sharing information on space Agencies exploration plans, including future missions and capability developments;

- Progress in the development of a reference architecture enabling the implementation of internationally developed mission scenarios for human lunar exploration and derive from the architecture priorities for the development of international interface standards;

- Raise awareness of the ISECG role and products among relevant stakeholders and establish working relations with other existing international working groups for mutual benefits;

- Develop a global strategy for conducting effective public engagement as an important pillar for sustained exploration;

- Explore opportunities and barriers for private sector engagement in global exploration;

- Map the Barriers to Robotic and Human Exploration and identify the significant, known technological and operational challenges associated with extending robotic and human presence to various Solar System destinations.

Results achieved on these objectives will be reported in the ISECG Annual Report 2009 and presented at major upcoming international conferences, including the International Astronautical Congress which will take place in Daejong Korea in October 2009.

THIS PAGE INTENTIONALLY BLANK

ANNEX I

HIGHLIGHTS
of
SPACE AGENCIES'
EXPLORATION ACTIVITIES

THIS PAGE INTENTIONALLY BLANK

ASI/Italy
Exploration Highlights

Introduction

The year 2008 has been characterized, for Italy as for the other ESA Member States, by the Ministerial Council held in November, hosted in Den Haag (The Netherlands) and chaired by Italy. During this event, Italy reaffirmed its leadership on the robotic mission ExoMars to be launched to Mars in 2016 and confirmed its commitment for its contribution to the European exploitation of the International Space Station.

It is worth noting that the Italian MPLM module Leonardo flew on the Shuttle mission STS126, launched on November 14th. Outstanding scientific results have been collected by the Italian instruments on-board the NASA Mars Reconnaissance Orbiter and ESA Mars Express missions. Last, in the framework of an AO for small missions, a lunar orbiter has been selected and the phase A study of such mission named MAGIA has been performed.

Past significant events and missions

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

- *Human exploration*
  - MPLM Leonardo flight on Shuttle mission STS126. Leonardo is one of the three Multi Purpose Logistics Modules build in Italy under a NASA-ASI agreement and used to bring up to seven tons of material, to the ISS.
  - ELITE-S2 (ELaboratore Immagini TElevisive for Space – 2nd edition): P/L developed to understand the effect of medium/long duration space flight on human task performances over time. This experiment has been carried out for 32 hours astronaut time during 2008 on ISS.
  - Life Support System activities (CAB Controllo Ambientale Biorigenerativo).
- *Robotic exploration*
  - Operations, data acquisition and analysis of Italian instruments on-board ESA Mars Express (MARSIS and PFS) and NASA MRO (SHARAD) missions. In particular, images provided by the radars allowed scientists to infer that the crust and the upper mantle of Mars are stiffer and colder than previously estimated and large deposits of ice have been identified at low latitudes.
  - Together with European partners, pre-PDR and PDR activities of ExoMars (Prime Contractor TAS-I) and PDRs of the Italian P/Ls (4 PI instrument plus contribution to other 5).
  - Completion of the joint feasibility study performed together with JAXA on the possibility to launch the Hayabusa-2 mission with the VEGA launch vehicle.
- *Earth based activities*
  - Prosecution of the activities related do the 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).
  - The development of a GIS (Geographical Information System) for Mars called PAGIS (Planetary Geosciences Information System) to elaborate and produce thematic maps is ongoing.

- Participation to the GES activities, IMEWG activities (in particular the MSR WG activities) and signature of the ILN SoI.
- The Italian astronaut Paolo Nespoli, as crew member of Expedition 26 to ISS, has been assigned for a launch in November 2010 on Soyuz 25 and return in May 2011 on Soyuz 25.
- An Italian Bed-Rest campaign of 7 weeks has been performed in Slovenia in head down (-6°) modality to simulate the physiological effects of microgravity on the human muscle-skeletal, cardiovascular and renal systems. The analyses of the results are ongoing.

Upcoming events

2009 will be an important year for Italy, as for the other countries part of the EU because of the Exploration Conference scheduled in June in Prague where the role of Europe in Exploration will be discussed. Also at national level, two out of five of the small missions selected in the 2008 AO will be selected for development and one of the mission in competition is the lunar orbiter previously mentioned. The MDS experiment (Mice Drawer System) is scheduled on flight 17A (August 2009) to ISS. Roberto Vittori will be assigned for launch in 2010 on the Shuttle.

Conclusion

Italy is strongly involved in robotic and human exploration activities. Currently our main objective is the participation to the Mars Sample Return mission and the utilization of the ISS. At the same time, we are still aiming at enhancing our expertise in the following fields: robotics systems, pressurized modules and life support systems.

BNSC/United Kingdom
Exploration Highlights

Introduction

In addition to its participation in ESA's Aurora Programme the UK is actively considering how to more widely engage in space exploration activities. Civil space activities in the UK are coordinated by the British National Space Centre (BNSC), a partnership of government bodies with involvement in space. The partner responsible for space exploration is the Science and Technology Facilities Council (STFC).

Highlights

The successful launch of India's Chandrayaan-1 spacecraft carried the UK's Chandrayaan-1 X-ray Spectrometer (C1XS) into orbit around the Moon. By early December it had taken its first successful measurements of the composition of the Moon. The instrument is part of ESA's contribution to Chandrayaan-1 and is an improved version of the demonstration model flown on ESA's SMART-1 spacecraft.

The main thrust of the UK's space exploration activities continues to be through ESA's Aurora programme. At the ESA Ministerial Conference in November 2008, the UK committed to an increase in its subscription to the ExoMars project from €101M to €165M and decided to commit funds to the ESA Mars Robotic Exploration Preparation programme (currently some 25% of the total funds subscribed).

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 (published in 2007, see http://www.stfc.ac.uk/UKSEWG) to produce a programme of activities that can be proposed to government for funding. This study is expected to be complete in the spring of 2009. The terms of reference of this study may be found on the BNSC web site (http://www.bnsc.gov.uk).

BNSC has also been working closely with NASA, considering areas of lunar research on which to cooperate. The final report of a Joint Working Group on lunar exploration was published in 2008 and identifies possible joint projects. These could include the Moon Lightweight Interior and Telecoms Experiment (MoonLITE) mission that would see the deployment of a series of penetrators to conduct measurements on the Moon as well as the joint development of science and technology needed for mid-term robotic and human exploration activities. The MoonLITE orbiter would act as a telecommunications station between the surface network and the Earth, relaying information to the Earth during the penetrators' one-year life. After that time it could act as a general-purpose communications relay. Following international peer review, STFC has now given approval for a 'Phase A' technical study to establish the feasibility of the overall mission, the penetrators and the penetrator descent systems.

During 2008, the UK has also developed a new strategy for its involvement in Mars Sample Return that sets out to provide expertise for a sample curation facility, develop technologies for a fetch-rover based on the UK-led rover for ExoMars and to provide instrumentation for sample selection.

As part of its commitment to increase the impact of space on education, BNSC has ran a series of high-profile competitions related to exploration during 2008. School children were invited to propose science experiments to be carried out by British-born space participant, Richard Garriott, during his visit to the ISS in October and to propose novel space exploration enterprises.

THIS PAGE INTENTIONALLY BLANK

CNES/France
Exploration Highlights

Introduction

As already mentioned, the main contribution of France to the exploration activities is through ESA's programs. However CNES is meanwhile developing complementary activities by providing instruments to the ESA's programs and by supporting the French scientific laboratories.

2008 Highlights:

In 2008 the political dimension of Exploration has been really emphasised in France at three different occasions:

- **Kourou 02/11/08**: During his first speech on the French Space Policy the French President recognized the importance of Space Exploration, robotic and human (*"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")*

The President proposed key references for the French vision for Exploration, based on the GES namely:

-*"We should work together to establish the framework for a dialogue with the US and other space powers to structure our efforts."*

- *"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."*

- **Kourou 07/21/08:** During the French Presidency of the European Union, the French government took the initiative of gathering together the 27 European Ministers in charge of Space (including ESA and the EC). They came to the conclusion that Exploration is of such paramount importance for Europe that a real political commitment should be taken at highest political level. Therefore a dedicated conference will be organised soon with European decisions makers to define the European vision for Exploration.

- **Den Haag 12/24/08:** At the Esa's Ministerial Council, France reaffirmed its position on Exploration by supporting its two major priorities: The ISS Utilisation both for science and as stepping stone for the preparation of the next European contribution to human exploration as well as Exomars.

The European Union's next Conference on Exploration in Prague next spring will highlight the direction France and Europe will take at their respective level.

THIS PAGE INTENTIONALLY BLANK

CSA/Canada
Exploration Highlights

Introduction

For Canada, the year 2008 could be characterized as the launch-year for in-depth technical studies of potential Canadian contributions to international space exploration initiatives, in addition to pursuing current activities in space exploration on the ISS and missions to Mars. Space in general and space exploration in particular has received renewed attention both from the government and the media.

2009 promises to be even more exciting with two Canadian astronauts scheduled for spaceflights, one being Canada's first on a six-month long-duration ISS Expedition crew, together with increased funding allocated for the development of terrestrial prototypes for future Moon and Mars exploration missions.

2008 Highlights:

Significant Canadian initiatives supporting space exploration during 2008:

- In March, Dextre the last robotics component of Canada's contribution to the ISS was launched and successfully installed. An essential, versatile tool for servicing the Station, Dextre is a dexterous two-armed robot capable of carrying out maintenance tasks including removing and replacing small components on the Station.
- The CSA continued to support the ISS operations for the Canadian Mobile Servicing System (MSS) with the fully operational MSS Mission Control Center at CSA and Robotics Mission Controllers at NASA-JSC. In addition the CSA continued with its training of astronauts and mission controllers, and made excellent progress in furthering MSS ground control operations (from CSA).
- Canadian scientists increased their use of the ISS. Two subjects completed the life sciences experiment Cardiovascular and Cerebrovascular Control on return from ISS.
- The Canadian weather station on the NASA Phoenix Mars lander marked the first time that Canada, as a nation, landed on the surface of Mars. The weather station's lidar instrument detected snow in the Martian atmosphere by detecting snowflakes falling from clouds about 4 kilometres above the spacecraft's landing site.
- In July, the CSA was the host for the second ISECG meeting.
- At the ESA Ministerial in November, the CSA confirmed its continuing participation to the ExoMars mission.
- The CSA launched a national astronaut recruitment campaign and received 5351 responses from highly educated, highly skilled Canadians. A final selection of two members of Canada's Astronaut Corps will be made during the spring of 2009.
- In 2008 the Canadian Space Agency inaugurated its Exploration Core Program with the aim of advancing potential Canadian contributions to international space exploration activities, while reducing risk and ensuring Canada's readiness to participate as a credible partner.
    - 18 concept studies evaluating various potential contributions to space exploration activities were completed and a final report is being prepared. These studies covered mobility on the Moon, on-orbit robotics, ISRU, science instruments for the Moon and Mars, manipulators and tools, vision systems, communications systems, and crew medical and life support systems.
    - Five contracts to build prototypes that will be tested in analogue sites were awarded. These contracts address mobility for ISRU, ISRU operational capabilities, navigation aids for human-sized rovers, rover guidance navigation and control and a terrestrial breadboard of a Mars science rover.

- The Canadian Analogue Research Network was again very active supporting analogue missions for science, technology and astronauts.
- A request for proposals was launched for nine phase zero studies to define user requirements and the feasibility of Canadian participation in various international space missions: ILN, Selene-2, Mars Sample Return, Mars Science Orbiter, Lunar mobility system, Lunar ISRU system and a robotic servicing module for a future exploration vehicle.
- The CSA participated in the NASA RESOLVE demonstration for ISRU in Hawaii.
- A science exploration workshop was also held in November to refine the science objectives for the exploration of the Moon and Mars.

Upcoming events:

2009 will be even more exciting with the following planned activities:

- In May Dr. Bob Thirsk will become the first Canadian astronaut to take part in a long-duration stay aboard the ISS and will be part of the first six-astronaut crew on the Station.
- In mid-June, Canadian astronaut Julie Payette will fly aboard the Space Shuttle flight STS-127 to install the external scientific platform on the Kibo module.
- In July, the Canadian 3D vision system for rendezvous and docking TriDAR will fly on the STS-128 as a demonstration for docking the Space Shuttle with the ISS.
- Canadian scientists will continue to access and use the ISS for science with the following planned experiments: Bodies in the Space Environment (BISE, a neuroscience experiment); APEX-CAMBIUM, a plant biology experiment with implications for forestry; VASCULAR, a study of the effects of space on the structure and function of blood vessels; Binary Colloid Alloy Test, a NASA-CSA collaboration examining the physics of colloid behaviour; and, SODI-IVIDIL, an ESA-CSA collaboration focusing on the fundamental nature of thermodiffusion.
- The Exploration Core Program activities will increase significantly with the additional funding allocated to the CSA by the Canadian Government in early 2009. These funds will foster the development of terrestrial prototypes of Moon and Mars rovers and other space technologies required to support exploration initiatives. The primary activities will be focused on on-orbit robotic servicing and mobility systems required for the Moon and Mars, along with the required sub-systems supporting science and ISRU. Intermediate deployments are planned to test the system leading to a major integrated deployment in 2012.
- In April, the CSA is planning a Canadian Exploration Workshop to validate exploration scenarios, discuss future plans and create opportunities for linkage between space and terrestrial industries.
- Following a vast consultation with space industry, academia, other government departments and space agencies, and approval by the Government of Canada, the Long Term Space Plan-IV may be released in spring 2010. With a twenty-year vision, the Plan will fully outline the objectives, orientations and investments that will be made over the next decade by the Canadian Space Program to fully respond to and support the priorities of Canada and Canadians.

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, 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.

Commonwealth Government query

In March 2008 the Australian Commonwealth Senate Standing Committee on Economics announced an enquiry around Australia's space science and industry. After hundreds of submissions and testimony the resulting publication makes several recommendations toward the coordination of Australia's space activities. The Australian Government (including CSIRO) is preparing a response. In parallel, reorganisation within CSIRO placed the CSIRO Office of Space Science and Application within the portfolio of Australia's representative to ISECG Dr. Miriam Baltuck. We are still working on a name for this group, but CSIRO Space has a nice ring! This entity is a co-investigator in a SMEX space science flight project proposal to NASA submitted in December 2008; if selected CSIRO will manage a government + academic team to provide ground support and data analysis.

Next Steps in 2009

Australia's path to contributing to ISECG goals lies in international cooperation. Our growing informal working group has met informally over 2008 and we have requested observer status in IMEWG to pursue possible areas of cooperation in a Mars Sample Return mission. Our ad hoc group has continued to expanding to include additional relevant activities and technologies as we continue to pursue avenues for our initial areas of focus. Thus 2009 will see us continuing to further existing dialogues and identify and pursue new possible partnerships.

THIS PAGE INTENTIONALLY BLANK

DLR/Germany
Exploration Highlights

ISS - DLR and German industry were intensively involved in the successful delivery and mating of Columbus as well as the successful launch, docking and de-orbiting of ATV. ALL Activities in the European laboratory are since February 2008 controlled by the Columbus Ground Control Centre, a DLR facility in Oberpfaffenhofen, Germany.

Lunar Exploration Orbiter - The German Space Agency DLR has continued the LEO mission preparation in 2008 with a phase-A study. The mission concept is based on a main satellite and two sub-satellites. The satellites can carry about 100 kg of payload for 15 experiments. LEO will provide a unique and complete set of integrated high-resolution data with global lunar coverage for a broad variety of scientific evaluations. Due to the missing funding decision in 2008, the mission preparation is now discontinued for some time. Results of the phase-A achieved so far, are secured.

Lunar Soft-Landing Demonstrator – first steps for the system definition with soft landing capabilities have been taken; this topic is regarded as crucial for future exploration tasks and scenarios.

Fuel Cell – a study on the technical feasibility of a regenerative/reversible fuel cell is conducted. It sets up on an existing unique German technology. The research looks very promising. The idea is to use fuel cells as energy storage and converter for future exploration missions, especially in missions with timely limited availability of solar power.

DGLR - the German Society for Aviation & Space (DGLR) organized a 3-day meeting in Bremen, from 15th September 2008 onwards. 15 countries participated in the “Moon & Beyond” conference. The organizers judged the quality of presentations & discussions as very good.

THIS PAGE INTENTIONALLY BLANK

ESA/Europe
Exploration Highlights

2008 proved to be a successful year for ESA as an international partner in the International Space Station endeavour. The European Columbus laboratory has become an integral part of the ISS since February 2008 and with a perfectly controlled re-entry high above the Pacific Ocean on 29 September, ESA's Jules Verne, the first Automated Transfer Vehicles (ATVs), successfully completed its six-month inaugural mission.

The first steps in scientific utilisation of Columbus took place during the assembly and commissioning mission itself in February. The external payload EuTEF (European Technology Exposure Facility) carried out the first Columbus experiment. EuTEF houses a suite of experiments requiring long-term exposure to open space and covering a variety of disciplines including material science, plasma physics, astrobiology, astronomy and space technology. All 13 experiments have successfully produced research results.

The astronaut selection campaign for new ESA astronauts, started in spring 2008, is entering its final phase.
Frank De Winne, of Belgian nationality and a member of the European Astronaut Corps, was selected to fly to the International Space Station in May 2009 for the start of a six-month mission. The OasISS mission sees him become the first European commander of the Station by October 2009.

On 25 and 26 November the ESA Council meeting at Ministerial level decided on major ESA programmes for the next three years. With regard to human spaceflight, ESA member states endorsed the following programme proposals:

- The **International Space Station (ISS) Exploitation Programme – Period 3** (timeframe 2008-2012), aimed at operating, maintaining and exploiting the European elements of the ISS and providing Europe's contribution to common operations by delivering cargo and services.
- The **European Transportation and Human Exploration Preparatory Activities Programme** (timeframe 2008-2011), which includes the initial definition phases of an ATV-based cargo download system - Advanced Re-entry Vehicle (ARV) - and studies on the definition of a Lunar Lander.
- The **ELIPS-Period 3 Programme** (timeframe 2008-2012), the continuation of the European Programme for Life and Physical Sciences.

The European Transportation and Human Exploration Preparatory Activities programme received good support securing future work on the Phase A of the Advanced Re-entry Vehicle, Lunar Lander activities and scenario studies analysing the European role in future human spaceflight and exploration as well as work on enabling technologies for transportation & exploration.

With regard to exploration, ESA member states endorsed the following programme proposals:

- The **ExoMars mission**, to be flown in 2016, with a simplification of the mission's architecture in parallel to a consolidation of the technical aspects to institute savings. This could include reduction of certain activities and a possible re-definition of the mission's goals, broadly in line with the initial mission concept, and searching for further contributions by international partners in the framework of a long-term cooperation.
- A **Mars Robotic Exploration Preparation** programme with the aim to prepare long-term technology goals leading to a Mars Sample Return mission, and system studies for intermediate missions' definition.

In cooperation with CNES, NASA and IMEWG, ESA organised an international event (8 July) where the iMARS work on an international architecture for a MSR mission concept was presented and debated in the context of future space exploration efforts.

Since February 2008, representatives from NASA and ESA have been engaged in detailed assessment of potential programs and technologies that when conducted cooperatively could one day support a human outpost on the Moon. The NASA-ESA comparative exploration architecture study was intended to assess the degree to which NASA and ESA's lunar exploration architecture concepts could complement, augment, or enhance the exploration plans of one another. Technical teams from each agency engaged in a series of joint, qualitative assessments of the potential scientific and exploration benefits that arise from collaboration between the ESA capabilities under study and NASA's Ares I and V space transportation systems and lunar surface exploration architecture concepts. A similar architecture study is also being initiated with JAXA.

The Heads of the International Space Station (ISS) Agencies from Canada, Europe, Japan, Russia and the United States met in July 2008 at ESA Headquarters in Paris, France, to review ISS cooperation. As part of their discussions, they noted the significantly expanded capability the ISS now provides for on-orbit research and technology development activities and as an engineering test-bed for flight systems and operations critical to future space exploration initiatives. They reviewed current ISS development, configuration and operations activities across the partnership.
As the partnership moves closer to completion of ISS assembly, the Heads of Agency reaffirmed their common interest in utilising the space station to its full capacity for a period meaningful for stakeholders and users.

The key focus of ESA's activities in the near future remains ISS utilisation and the European participation in the International Space Station operations via the ESA ISS Exploitation programme, including the production of further ATVs to fulfil Europe's obligations. It is also focused on the preparation of the ExoMars mission, the ISS lifetime extension and the lunar lander development activities.

JAXA-JSPEC/Japan
Exploration Highlights

In 2008, there were many achievements in space exploration activities in relation to JAXA/JSPEC.

- The Establishment of International Primitivebody Working Group (IPEWG) and its first meeting

In order to promote international collaborations and to maximize outcomes of missions on primitive body exploration, the first International Primitive Body Exploration Working Group (IPEWG) meeting was held in 14-16 January 2008 in Okinawa, Japan hosted by JAXA. More than 50 participants from space agencies, scientists, engineers and other interested stakeholders were participated in the meeting and many fruitful discussions and presentations (oral & poster) were made. It was agreed that JAXA will play a role of Secretariat and the IPEWG meeting will be held every two years. Next meeting will be in 2010 by the NASA's voluntary host.

- "Kibo" has attached to the ISS

The Japanese Experiment Module (JEM), known as "Kibo" which means hope in Japanese, is Japan's first human-rated space facility and JAXA's first contribution to the International Space Station (ISS) program. Kibo was mainly designed and developed with a view to conducting scientific research activities on orbit. In Kibo, a maximum of four astronauts can perform experimental activities.

In mid-March 2008, JAXA's Astronaut, Takao Doi flew to the ISS with Kibo's stowage module, Experiment Logistic Module-Pressurized Section (ELM-PS). Another JAXA's Astronaut, Akihiko Hoshide joined the mission to the ISS with Kibo's main experiment module, Pressurized Module (PM), and Kibo's robotic arm, JEMRMS in June 2008. The rests of Kibo's components, the Exposed Facility and the ELM's Exposed Section (ELM-ES) are scheduled to be launched and to attach the ISS around mid of 2009. Inside of the Kibo's PM, JAXA currently performs various experiments utilizing microgravity environment.

- Scientific data from Kaguya has been brought us a various knowledge as well as impressed images

JAXA's Lunar orbiting explorer "Kaguya" has taken a lot of scientific data by 14 instruments onboard and its results are appeared in scientific journal and in public. After successful operation phase of Kaguya for about 1 year, post-operation phase has started from November 2008.

- Selene-2 and Hayabusa-2/Marco Polo

SELENE-2, aiming to acquire the lunar soft landing and rover technology and in-situ scientific data is under phase-A study. JAXA/JSPEC hopes its launch around mid of 2010s.

Hayabusa-2 and Marco Polo are robotic sample return missions, succeeding Hayabusa project, toward elucidation of the origin and evolution of our solar system and life.
Hayabusa-2 is in the phase-A study and Marco Polo, the Japan and Europe joint mission, won the first selection of ESA's Cosmic Vision Program.

- Space Basic Law and establishment of Strategic Headquarters for Space Development

In August 28, 2008, Space Basic Law was enforced and to promote space policy in Japan comprehensively, the Strategic Headquarters for Space Development was established in the Cabinet headed by the Prime Minister of Japan.

NASA/United States of America
Exploration Highlights

Introduction: 2008 marked another series of accomplishments in NASA's human and robotic exploration programs – we landed on Mars, added to the International Space Station, took part in a lunar science mission with India and made major progress toward returning astronauts to the Moon as the agency celebrated its 50th birthday in 2008.
Some of the highlights of NASA's golden anniversary year are listed below, along with links for further information.

Human Spaceflight: NASA completed four Shuttle missions to the International Space Station (ISS) in 2008, delivering modules and hardware allowing ISS to house six crew members for long-duration missions in support of scientific exploration. The activation in 2008 of the European Space Agency's Columbus module and Jules Verne Automated Transfer Vehicle, as well as the Japan Aerospace Exploration Agency's Kibo laboratory, marked the beginning of new human spaceflight control centers in Germany, France and Japan that are working with existing control centers in the U.S., Russia and Canada.

http://www.nasa.gov/mission_pages/station/main/10th_main.html

Robotic Exploration: NASA's Phoenix Mars Lander safely reached a soft landing on Mars on May 25 – a site farther north than where any previous spacecraft had landed. The mission, which included contributions by the Canadian Space Agency and other partners, successfully returned unprecedented science data to Earth, advancing the goal of documenting the history of water on Mars. Analysis of data from its instruments continues. http://www.nasa.gov/phoenix. NASA has also partnered with India to fly two science instruments aboard the country's first lunar explorer, Chandrayaan-1. The Indian Space Research Organization launched Chandrayaan-1 on October 22 from Sriharikota, India, entering lunar orbit on Nov. 8. NASA's Moon Mineralogy Mapper is surveying mineral resources of the Moon, and the Miniature Synthetic Aperture Radar is mapping the Moon's polar regions and looking for ice deposits in the permanently shadowed craters. Data from the two instruments is contributing to NASA's increased understanding of the lunar environment as we prepare for future robotic and human missions to theMmoon, http://moonmineralogymapper.jpl.nasa.gov/

Human Exploration: NASA successfully completed the preliminary design review for the new Ares I rocket in 2008. Starting in 2015, Ares I will launch the Orion crew exploration vehicle and its crew of four to six astronauts to the ISS. The rocket also will be used as part of missions to explore the Moon and beyond in coming decades. NASA is preparing Ares I for its first test flight in 2009. http://www.nasa.gov/ares NASA engineers also successfully completed in 2008 the first series of tests in the early development of the J-2X engine that will power the upper stages of the Ares I and Ares V rockets. Ares V will carry cargo and components into orbit for trips to the Moon and later to Mars.
http://www.nasa.gov/home/hqnews/2008/may/HQ_08116_power_pack_tests.html. Finally, NASA completed the important Lunar Capability Concept Review milestone in 2008, confirming that conceptual designs for both Ares V and the Altair lunar lander were capable of landing astronauts and cargo anywhere on the Moon and to building an outpost supporting widespread exploration of the lunar surface.

THIS PAGE INTENTIONALLY BLANK

NSAU/Ukraine
Exploration Highlights

The year 2008 has been characterized by several events related to Exploration.

Agreements

Framework agreements of cooperation were signed with NASA, ESA, CNES and DLR.
NSAU considers signing of these agreements as the path to contributing to ISECG goals in international cooperation. We anticipate activation of negotiation processes in the areas of joint interests with these agencies.

The realization of Ukrainian-European Twinning Project "Boosting Ukrainian Space Cooperation with the European Union" started in March 2008. CNES and DLR were defined as a partner for NSAU in the Twinning Project by the European Evaluation Commission. The purpose of project is to support Ukraine for its involvement to the European Research Area and European Space programs.

New National Space Program for 2008-2012 years

National Space Program for 2008-2012 years was approved by Ukrainian Parliament as a low in September 2008. As the part of the Program NSAU will continue the following activities related to Exploration:

- Participation of Ukrainian organizations in developing of scientific instruments for Russian space projects, such as "Spectr-R" (flux-gate magnetometer LEMI-604); "Fobos-Ground" (wave probes LEMI-605); "Coronas-Photon" (sensor of energetic particles STEP) was launched on January 30, 2009.
- Development of experiments ("Obstanovka", "Morphos", "Material-Friction", "Penta-Fatigue", "Trubka", "Spectrometer-Polarimeter", "Biosorbent", "Biopolymer", "Biolaboratory-M") in material sciences, life sciences, environment, and astrophysics in accordance with the "Joint Program of Space Experiments on board the Russian Segments of International Space Station".

Response to the Global Exploration Strategy

Following publication of "The Global Exploration Strategy: The Framework of cooperation" in Ukrainian for wide community, NSAU has initiated discussion with Ukrainian academic and industrial scientists and engineers in 2007. The "Call of ideas" to elaborate a national Exploration strategy was launched. NSAU will integrate the output of this "Call of ideas" and results of round-table discussion in September 2009 to the draft of "Exploration –Ukraine" program.

Next steps in 2009

NSAU will complete the "Space Strategy of Ukraine till 2030" and represent it to the Government by the 1st of June 2009.