Глобальна стратегія дослідження Місяця

14 січня 2004 р. президент США Джордж Буш-молодший виступив в штаб-квартирі НАСА з новою ініціативою з освоєння космічного простору, орієнтованою на відновлення пілотованих польотів на Місяць та його активне освоєння, а також організацію експедицій на Марс та інші планети Сонячної системи. Ця ініціатива викликала широкий резонанс у світі. Створення населеної бази на Місяці, у тому числі і як стартової платформи для польотів до інших світів, стало першочерговим завданням цієї програми.

На початку 2006 р. один з керівних органів НАСА (Exploration Systems Mission Directorate) ініціював створення глобальної дослідницької стратегії, орієнтованої перш за все на дослідження Місяця. Основна мета цієї стратегії — дати відповідь на два ключових питання: «Чому ми повинні повернутись до Місяця?» і «Що ми зби-

Table 1. Lunar Exploration Themes. (Why are we going to the Moon?)

Theme	Description
	Core Themes
1. Use the Moon to prepare for future human missions to Mars and other destinations.	Reduce the risks and increase the productivity of future missions in our solar system by testing technologies, systems, and operations in an off-Earth planetary environment.
2. Pursue scientific activities to address fundamental questions about the solar system, the universe, and our place in them.	Engage in scientific investigations: — ***Of the Moon***: Study the history of the Moon and the current lunar environment to learn about the evolution of our solar system; — ***On the Moon***: Understand the effects of the lunar environment on the Moon's inhabitants and their equipment; — ***From the Moon***: Use the Moon as a platform for performing scientific investigations, observing the Earth and other celestial phenomena.
3. Extend sustained human presence to the Moon to enable eventual settlement.	Develop the knowledge, capabilities, and infrastructure required to live and work on the Moon, with a focus on continually increasing — The number of individuals that can be supported on the Moon; — The duration of time that individuals can remain on the Moon; — The level of self-sufficiency of lunar operations; — The degree of non-governmental activity.
	Crosscutting Themes
4. Expand Earth's economic sphere to encompass the Moon, and pursue lunar activities with direct benefits to life on Earth.	Create new markets, based on lunar and cis-lunar activity, that will return economic, technological, and quality-of-life benefits to all humankind.
5. Strengthen existing and create new global partnerships.	Enhance global security by providing a challenging, shared, and peaceful global vision that unites nations in collaborative pursuit of common objectives.
6. Engage, inspire, and educate the public.	Use a vibrant exploration program to excite the public about space, encourage students to pursue careers in high technology fields, and ensure that individuals enter the workforce with the scientific and technical knowledge necessary to sustain exploration.

раємось там робити?» НАСА запевняє численні національні космічні агентства, а також комерційні і академічні співтовариства в тому, що всі їхні інтереси знайдуть відображення в цій стратегії. Тому вона пропонується для всестороннього обговорення.

Хоча на першому етапі цієї стратегії увага зосереджується на автоматичних і пілотованих дослідженнях Місяця, у майбутньому вона буде зосереджуватись на дослідженнях Марса та інших об'єктів. НАСА виділяє шість ключових тем глобальної стратегії досліджень Місяця (Table 1), а конкретні цілі цих досліджень сформульовані для 23 категорій, які охоплюють різні сфери людської діяльності (Table 2).

Table 2. Lunar Exploration Objectives

Category	Objective e ID Number	Name
Astronomy and Astrophysics	mA1	Perform radio astronomy from the Moon to observe the Sun and other astronomical objects.
	mA2	Perform interferometry on the lunar surface.
	mA3	Perform optical/near-infrared astronomy from the Moon.
	mA4	Detect gravitational waves to understand gravitational physics and test theories of General Relativity.
	mA5	Detect and monitor exoplanets.
	mA6	Perform long-duration study of energetic phenomena visible from the Moon.
	mA7	Use the Moon to search for cold dark matter candidates.
Earth Observation	mEO1	Use the Moon as a remote sensing platform for monitoring the Earth.
Geology	mGEO1(1-4)	Understand the origin and structure of the Moon.
	mGEO2	Characterize new impact events similar to those that would degrade more quickly on other planets.
	mGEO3(1-2)	Characterize the broad geology of the Moon.
	mGEO4(1-2)	Characterize impact cratering flux over the Moon's geologic history.
	mGEO5(1-2)	Study meteorite impactors on the Moon.
	mGEO6	Understand the nature and history of solar emissions.
	mGEO7	Characterize and understand the regolith.
	mGEO8(1-2)	Characterize lunar volatiles.
Materials Science	mMAT1	Study the affects of the lunar environment on materials so as to design mitigation strategies for extended stays.
Human Health	mHH1	Study the effects of the lunar environment on human health so as to design mitigation strategies for extended stays.
	mHH2	Understand the affects of fractional gravity on human performance and human factors.
	mHH3	Improve remote medical practice infrastructure and technology for fractional gravity to improve health care on the Moon.
Environmental Characterization	mENVCH1	Characterize the lunar thermal environment to better understand the operational environment of the Moon.
	mENVCH2	Characterize geotechnical properties of surface materials to support lunar civil engineering.
	mENVCH3	Characterize radiation bombardment of the lunar surface to better understand the operational environment of the Moon.
	mENVCH4	Characterize micrometeorite bombardment of the lunar surface to better understand the operational environment of the Moon.
	mENVCH5	Characterize the dust environment of the lunar surface to better understand the operational environment of the Moon.
Operational Support Science	mOSS1	Engage in «kitchen science» activities to learn how to function in the lunar environment.
Life support and Habitat	mLSH1	Provide safe and enduring habitation systems to protect individuals, equipment, and associated infrastructure.
	mLSH2	Develop biologically based life support system components to support long duration human exploration missions.
	mLSH3	Develop and deploy Closed Life Loop Support Systems to increase self sufficiency of future long duration human exploration missions.

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Category	Objective e ID Number	Name
	mLSH4	Utilize the commercial sector to provide agriculture services on the Moon to support life support systems.
	mLSH5	Utilize the commercial sector to provide food services on the Moon to support human habitation.
	mLSH6	Utilize the commercial sector to provide waste management services on the Moon to aid life support.
	mLSH7	Utilize the commercial sector to provide health care services on the Moon to aid life support operations.
Environmental Hazard Mitigation	mEHM1	Provide radiation shielding for surface operations to protect crews, materials, and instruments.
	mEHM2	Evaluate and employ dust mitigation techniques to protect crews, materials and instruments during extended lunar stays.
Power	mPWR1	Develop power generation and storage systems required to facilitate increasing surface durations.
	mPWR2	Establish a power architecture where Earth-generated power is transmitted to the lunar surface and to cis-lunar transportation assets.
Communication	mCOM1	Implement a reliable and scalable telecommunications capability to support expanding telecom needs.
	mCOM2	Establish a commercial communications network that can provide high-bandwidth support for public engagement.
	mCOM3	Utilize the commercial sector to provide information services to the greatest extent possible.
Guidance, Navigation, and Control	mNAV1	Establish GNC capabilities to support lunar operations.
Surface Mobility	mSM1	Implement surface mobility systems to support both crew and cargo traverses over increasing distances.
Transportation	mTRANS1	Utilize the commercional sector to provide transportation services on the Moon and to and from the Moon to increase access to the Moon and traversing the Moon.
	mTRANS2	Demonstrate autonomous lander.
Operational Environmental Monitoring	mENVMON1	Monitor space weather to determine risks to lunar inhabitants.
	mENVMON2	Monitor real-time environmental variables affecting safe operations.
General Infrastructure	mGINF1	Utilize the commercial sector to provide finance and insurance services to support businesses operating on the Moon.
	mGINF2	Utilize the commercial sector to provide warehousing services on the Moon to support the lunar base.
	mGINF3	Utilize the commercial sector to develop infrastructure and utilities systems on the Moon to aid lunar operations.
	mGINF4	Emplace support services on the Moon to enable increased activities.
	mGINF5	Develop lunar rescue systems.
Operations, Test, and Verification	mOPS1	Demonstrate human surface operations capability.
	mOPS2	Demonstrate remote training and planning.
	mOPS3	Conduct Mars Analog tests on the lunar surface.
	mOPS4	Create a commercial astronaut corp to provide scientific, technical, and mission support to aid lunar science and operations.
	mOPS5	Utilize the commercial sector to provide arts, entertainment, and recreation on the Moon to provide leisure activities for those living on and visiting the Moon.
	mOPS6	Take advantage of the unique lunar environment to create recreation activities for lunar crews and visitors.
	mOPS7	Evaluate astrobiology protocols and technologies that will be used to search for life on other planets.
Lunar Resource Utilization	mLRU1	Understand the resource potential of the Moon.
	mLRU2	Use lunar resources to enable and support future exploration missions and destinations.
	mLRU3	Reduce reliance on Earth to create a self-sustaining lunar ecology.
	mLRU5	Prove safe utilization of ISRU resources.

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Category	Objective e ID Number	Name
	mLRU6	Utilize the commercial sector to provide construction services on the Moon to aid lunar base development.
	mLRU7	Utilize the commercial sector to provide manufacturing services on the Moon to aid ISRU.
	mLRU8	Provide Earth with energy derived from lunar resources.
	mLRU9	Perform lunar resources excavation, transport, delivery and construction on the lunar surface.
	mLRU10	Develop and demonstrate tools, technologies and systems to extract and process resources on the Moon.
Historic Preservation	mHISP1	Create international lunar heritage sites to protect the record of early human lunar activity.
	mHISP2	Preserve an archive of Earth's civilization to mitigate the effects of any potential catastrophic events on Earth.
Commerce	mC1	Involve the commercial sector early on and throughout lunar development to embed them in all aspects of lunar activities and increase their involvement.
	mC2	Utilize public-private models to provide goods and services to jump-start commercial sector involvement.
	mC3	Create opportunities for commercialization pilot programs to enable low-cost development of commercial goods and services.
	mC4	Develop profitable lunar products for Earth and in-space use to demonstrate and take advantage of the commercial potential of the Moon.
	mC5	Create a strategy for transferring all aspects of government lunar activities to private industry to enable the shift of government resources to the next generation of projects and enhance commercial involvement on the Moon.
	mC6	Utilize government resources to catalyze more «exotic» industries for eventual ownership and operation by commercial firms.
	mC7	Establish the legal framework required to support commercial collaboration/cooperation on lunar exploration.
Global Partnership	mGP1	Establish a global partnership framework to enable all interested parties (including non-space faring nations and private companies) to participate in lunar exploration.
	mGP2	Establish standards and common interface designs to enable interoperability of systems developed by a global community.
	mGP3	Establish the legal framework required to support global collaboration/cooperation on lunar exploration.
	mGP4	As necessary, establish appropriate legal governance of lunar surface and orbital activities to enable commercial and governmental involvement.
	mGP5	Establish internationally recognized planetary protection mechanisms to prevent forward and backward contamination of the Moon.
	mGP6	Create a model society on the Moon.
Public Engagement and Inspiration	mEOR1	Provide opportunities to engage the public through direct and indirect participation in lunar activities to increase public support of the space program.
	mEOR2	Extend awareness of space activities to diverse, non-traditional communities, utilizing non-traditional means, to enhance public engagement.
	mEOR3	Demonstrate the value of lunar activities for Earth to raise public awareness of the lunar exploration program.
	mEOR4	Provide opportunities to educate students through direct and indirect participation in lunar activities to engage students in the space program.
Program Execution	mPE1	Reduce bureaucracy associated with national space programs.
	mPE2	Define and execute a long-term exploration strategy, that includes the objectives of all stakeholders, to organize and time-phase future activities.