Full Text: China's Space Activities in 2016

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BEIJING, Dec. 27 (Xinhua) -- The Information Office of the State Council on Tuesday published a white paper on China's space activities in 2016.

Following is the full text:

China's Space Activities in 2016

The State Council Information Office of the People's Republic of China

December 2016

First Edition 2016

Preamble

Space activities make up one of the most challenging hi-tech fields which exert enormous impact on other fields. Space activities have greatly improved man's knowledge of space, and provide an important driving force for social progress. Currently, more and more countries, including developing ones, are making the development of space activities an important strategic choice. Thus space activities around the world are flourishing.

The Chinese government takes the space industry as an important part of the nation's overall development strategy, and adheres to the principle of exploration and utilization of outer space for peaceful purposes. Over the past 60 years of remarkable development since its space industry was established in 1956, China has made great achievements in this sphere, including the development of atomic and hydrogen bombs, missiles, man-made satellites, manned spaceflight and lunar probe. It has opened up a path of self-reliance and independent innovation, and has created the spirit of China's space industry. To carry forward this spirit and stimulate enthusiasm for innovation, the Chinese government set April 24 as China's Space Day in 2016.

"To explore the vast cosmos, develop the space industry and build China into a space power is a dream we pursue unremittingly." In the next five years and beyond China will uphold the concepts of innovative, balanced, green, open and shared development, and promote the comprehensive development of space science, space technology and space applications, so as to contribute more to both serving national development and improving the well-being of mankind.

To enable the world community to better understand China's space industry, we are publishing this white paper to offer a brief introduction to the major achievements China has made in this field since 2011, its main tasks in the next five years, and its international exchanges and cooperation efforts.

I. Purposes, Vision and Principles of Development

1. Purposes

To explore outer space and enhance understanding of the earth and the cosmos; to utilize outer space for peaceful purposes, promote human civilization and social progress, and benefit the whole of mankind; to meet the demands of economic, scientific and technological development, national security and social progress; and to improve the scientific and cultural levels of the Chinese people, protect China's national rights and interests, and build up its overall strength.

2. Vision

To build China into a space power in all respects, with the capabilities to make innovations independently, to make scientific discovery and research at the cutting edge, to promote strong and sustained economic and social development, to effectively and reliably guarantee national security, to exercise sound and efficient governance, and to carry out mutually beneficial international exchanges and cooperation; to have an advanced and open space science and technology industry, stable and reliable space infrastructure, pioneering and innovative professionals, and a rich and profound space spirit; to provide strong support for the realization of the Chinese Dream of the renewal of the Chinese nation, and make positive contributions to human civilization and progress.

3. Principles

China's space industry is subject to and serves the national overall development strategy, and adheres to the principles of innovative, coordinated, peaceful and open development.

- Innovative development. China takes independent innovation as the core of the development of its space industry. It implements major space science and technology projects, strengthens scientific exploration and technological innovation, deepens institutional reforms, and stimulates innovation and creativity, working to promote rapid development of the space industry.

- Coordinated development. China rationally allocates various resources, encourages and guides social forces to take an orderly part in space development. All space activities are coordinated under an overall plan of the state to promote the comprehensive development of space science, space technology and space applications, and to improve the quality and efficiency of overall space development.

- Peaceful development. China always adheres to the principle of the use of outer space for peaceful purposes, and opposes the weaponization of or an arms race in outer space. The country develops and utilizes space resources in a prudent manner, takes effective measures to protect the space environment to ensure a peaceful and clean outer space and guarantee that its space activities benefit the whole of mankind.

- Open development. China persists in combining independence and self-reliance with opening to the outside world and international cooperation. It actively engages in international exchanges and cooperation on the basis of equality and mutual benefit, peaceful utilization, and inclusive development, striving to promote progress of space industry for mankind as a whole and its long-term sustainable development.

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II. Major Developments Since 2011

Since 2011 China's space industry has witnessed rapid progress manifested by markedly enhanced capacity in independent innovation and access to outer space, constant improvement in space infrastructure, smooth implementation of major projects such as manned spaceflight, lunar exploration, the Beidou Navigation System and high-resolution earth observation system, and substantial achievements in space science, technology and applications.

1.Space transportation system

From 2011 to November 2016 the Long March carrier rocket series completed 86 launch missions, sending over 100 spacecraft into target orbit with a success rate of 97.67 percent, indication of increasing effectiveness and high-density launching capability of carrier rockets. The Long March 5 (CZ-5), China's newest generation of carrier rockets with a maximum carrying capacity, made its maiden flight, and increased the diameter of liquid fuel rocket from 3.35 m to 5 m, with a maximum payload capacity of about 25 tons to low earth orbit and about 14 tons to geostationary transfer orbit, significantly improving the carrying capacity of the Long March rocket family and becoming a symbol of the upgrading of China's carrier rockets. The development of the 120-ton liquid oxygen and kerosene engine was test fired, which powered Long March 6 and Long March 7 on their maiden flights. The Long March 11, a solid-fuel carrier rocket, also made a successful maiden launch, further enriching the Long March rocket family.

2. Man-made satellites

(1) Earth observation satellites. The function of the Fengyun (Wind and Cloud), Haiyang (Ocean), Ziyuan (Resources), Gaofen (High Resolution), Yaogan (Remote-Sensing) and Tianhui (Space Mapping) satellite series and constellation of small satellites for environment and disaster monitoring and forecasting has been improved. The Fengyun polar orbit meteorological satellite has succeeded in networking observation by morning and afternoon satellites, while its geostationary earth orbit (GEO) meteorological satellite has formed a business mode of "multi-satellites in orbit, coordinated operation, mutual backup and encryption at the appropriate time." The Haiyang-2 satellite is capable of all-weather, full-time and high-accuracy observation of marine dynamic parameters such as sea height, sea wave and sea surface wind. The Ziyuan-1 02C satellite was launched, the Ziyuan-3 01 and 02 stereo mapping satellites have achieved double star networking and operating. The China High-resolution Earth Observation System program has been fully implemented; the Gaofen-2 is capable of sub-meter optical remote-sensing observation, the Gaofen-3 has a Synthetic Aperture Radar (SAR) imaging instrument that is accurate to one meter and the Gaofen-4 is China's first geosynchronous orbit high-resolution earth observation satellite. Satellite C of the environment and disaster monitoring and forecasting small satellite constellation has been put into use. The successful launching of the Kuaizhou-1 and Kuaizhou-2, which adopted integrated design of the satellite and the launch vehicle, has improved China's emergency response capability in space. The Jilin-1, a high-resolution remote-sensing satellite for commercial use has been launched and put into service.

(2) Communications and broadcasting satellites. China has comprehensively advanced the construction of fixed, mobile and data relay satellite systems. The successful launch of communications satellites such as Yatai and Zhongxing represented the completion of a fixed communications satellite support system whose communications services cover all of China's territory as well as major areas of the world. The Tiantong-1, China's first mobile communications satellite, has been successfully launched. The first-generation data relay satellite system composed of three Tianlian-1 satellites has been completed, and high-speed communication test of satellite-ground laser link has been crowned with success. In addition, the development of the DFH-5 super communications satellite platform is going smoothly.

(3) Navigation and positioning satellites. The Beidou Navigation Satellite System (Beidou-2) has been completed, with the networking of 14 Beidou navigation satellites, officially offering positioning, velocity measurement, timing, wide area difference and short-message communication service to customers in the Asia-Pacific region. Beidou's global satellite navigation system is

undergoing smooth construction.

(4) New technological test satellites. China has launched the Shijian-9 satellite series for technological experiments, providing an important way to test new technologies.

3. Manned spaceflight

In June 2012 and June 2013, the Shenzhou-9 and Shenzhou-10 manned spacecraft were launched to dock with the target spacecraft Tiangong-1. They used manual and automatic operations respectively, symbolizing breakthroughs for China in spacecraft rendezvous and docking technology and full success in its first operation of a manned space transportation system. In September and October 2016 the Tiangong-2 space laboratory and Shenzhou-11 manned spacecraft were launched and formed an assembly that operates steadily, with the mission of carrying out science and technology experiments in space, indicating that China has mastered technologies concerning astronauts' mid-term stay in orbit, and long-term ground mission support. Currently, China has mastered major space technologies such as manned space transportation, space extravehicular activity, space docking, operating in assembly and astronauts' mid-term stay in orbit.

4. Deep space exploration

In December 2012 the Chang'e-2 lunar probe made a successful observation trip over asteroid 4179 (Toutatis). In December 2013 the Chang'e-3 realized the first soft landing on the surface of an extraterrestrial body by a Chinese spacecraft and completed patrol and exploration on the surface of the moon. In November 2014 China achieved success in the reentry and return flight test of the third-phase lunar exploration engineering, indicating that China has mastered the key technology of spacecraft reentry and return flight in a speed close to second cosmic velocity.

The Lunar Exploration Program helped mankind to acquire a high-resolution map of the moon and a high-definition image of Sinus Iridum, and conducted research of lunar surface morphology, lunar structure, elemental composition of the lunar surface, lunar surface environment, lunar space environment and moon-based astronomical observation.

5. Space launch sites

In June 2016 the Wenchang Launch Site held its first launch, marking a new-generation launch site designed and built by China. The site is environmentally friendly and made breakthroughs in innovation. Renovations have also been accomplished in the Jiuquan, Taiyuan and Xichang launch sites, forming a launch site network covering both coastal and inland areas, high and low altitudes, and various trajectories to satisfy the launch needs of manned spaceships, space laboratory core modules, deep space probes and all kinds of satellites.

6. Space Telemetry, Tracking and Command (TT&C)

The Tianlian-1 data relay satellite series have achieved global networking and operating. The Yuanwang-7, a spacecraft tracking ship has made its maiden voyage. Deep space TT&C stations have been built and put into use. China is constantly improving its space telemetry, tracking and command setups, and established a multi-functioning TT&C network featuring space, marine and ground integration with a proper scale. The flight control ability of spacecraft has been gradually improved, completing the TT&C missions of the Shenzhou spacecraft series, Tiangong-1 target spacecraft, Chang'e lunar probe series and earth orbit satellites.

7. Space applications

(1) Application of earth observation satellites. The ground system and applications of earth observation satellites are improving, the fields and levels in which these satellites are used are expanding and the application benefits are growing. The ground stations receiving data from land, ocean and meteorological observation satellites are operating based on comprehensive planning, a satellite data ground network with the capacity of receiving data from high- and low-orbit satellites and reasonable arrangement at home and abroad. China has also established, based on comprehensive planning, a ground data processing system for earth observation satellites, common application supporting platform, and multi-level network data distribution system, greatly increasing its ability in data processing, archiving, distribution, services provision and quantitative applications. Industrial application system building is in full swing, having completed 18 industrial and two regional application demonstration systems, and set up 26 provincial-level data and application centers. An integrated information service sharing platform for a high-resolution earth observation system has been built. Earth observation satellite data is now widely used in industrial, regional and public services for economic and social development.

(2) Application of communications and broadcasting satellites. The ground facilities such as TT&C station, gateway station, uplink station and calibration field of communications satellites have been improved. A satellite communications network and satellite radio and TV network of adequate scale to meet the needs of certain services have been built, further improving the communications service ability. These applications play an important role in radio and television services, distance education and telemedicine. The emergency satellite communications system has provided important support for the fight against flood

and drought, for rescue and relief work, and for handling major emergencies.

(3) Application of navigation and positioning satellites. The Beidou Navigation Satellite System has significantly improved its accuracy and reliability, bringing into play an independent, controllable, complete and mature Beidou industrial chain and the three systems of Beidou industrial guarantee, application promotion and innovation. The Beidou Navigation System is widely used in transportation, maritime fisheries, hydrological monitoring, weather forecasting, surveying and mapping, forest fire prevention, time synchronization of communication, power dispatching, disaster reduction and relief and emergency rescue, influencing all aspects of people's life and production, and injecting new vitality into global economic and social development.

(4) Transformation and application of space technology. A new business model featuring the Internet plus satellite applications is coming into being, providing more convenient and high-quality services to the public. Secondary development, transformation and applications of space technology make possible the provision of high-quality products and services to relevant industries, and help to support and propel the development of new materials, intelligent manufacturing and electronic information, among others.

8. Space science

(1) Space science satellites. China has successfully launched the Dark Matter Particle Explorer, Shijian-10 and Quantum Science Experiment Satellite, offering important means for frontier scientific research.

(2) Space environment scientific experiments. China has carried out a series of space science experiments using space science satellites, Chang'e lunar probe, Shenzhou spacecraft series and Tiangong-1 target aircraft, deepening the understanding of the mechanism of biological growth and materials preparation under the conditions of space microgravity and intense radiation, and achieving some influential research findings.

(3) Space environment detection and forecast. China has identified the space environment's major parameters and effects using space science satellites and the Shenzhou spacecraft series to provide space environmental monitoring and forecasting services for the safe operation of spacecraft.

9. Space debris

China has improved the monitoring and mitigation of and early warning and protection against space debris. It has also enhanced standards and regulations in this regard. The monitoring of and early warning against space debris have been put into regular operation, ensuring the safe operation of spacecraft in orbit. China has also made breakthroughs in protection design technologies, applying them to the protection projects of spacecraft against space debris. In addition, all Long March carrier rockets have upper stage passivation, and discarded spacecraft are moved out of orbit to protect the space environment.

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III. Major Tasks for the Next Five Years

In the next five years China plans to expedite the development of its space endeavors by continuing to enhance the basic capacities of its space industry, strengthen research into key and cutting-edge technologies, and implement manned spaceflight, lunar exploration, the Beidou Navigation Satellite System, high-resolution earth observation system, new-generation launch vehicles and other important projects. Furthermore, the country is to launch new key scientific and technological programs and major projects, complete, by and large, its space infrastructure system, expand its space applications in breadth and depth, and further conduct research into space science, promoting the integrated development of space science, technology and applications.

1. Space transport system

We will develop and launch medium-lift launch vehicles which are non-toxic and pollution-free, improve the new-generation launch vehicle family, and enhance their reliability.

Endeavors will be made to research key technologies and further study the plans for developing heavy-lift launch vehicles. Breakthroughs are expected in key technologies for the overall system, high-thrust liquid oxygen and kerosene engines, and oxygen and hydrogen engines of such launch vehicles. Thereafter the heavy-lift launch vehicle project will be activated.

China will conduct research into the technologies for low-cost launch vehicles, new upper stage and the reusable space transportation system between the earth and low-earth orbit.

2. Space infrastructure

China is to improve its satellite systems and their basic related items, develop the three major satellite systems of remote-sensing, communications and broadcasting, and navigation and positioning, and build a space-ground integrated information network. In this way, a space infrastructure system capable of providing steady and sustained services will take shape, boosting the satellite and related applications industrial sector.

(1) Satellite remote-sensing system. In accordance with the policy guideline for developing multi-functional satellites, and creating networks of satellites and integrating them, we will focus on three series of satellites for observing the land, ocean and atmosphere, respectively. China is to develop and launch satellites capable of high-resolution multi-mode optical observation, L-band differential interferometric synthetic aperture radar imaging, carbon monitoring of the territorial ecosystem, atmospheric Lidar detection, ocean salinity detection and new-type ocean color observation. We will take steps to build our capabilities of highly efficient, comprehensive global observation and data acquisition with a rational allocation of low-, medium- and high-spatial resolution technologies, and an optimized combination of multiple observation methods. China will make overall construction and improvement on remote-sensing satellite receiving station networks, calibration and validation fields, data centers, data-sharing platforms and common application supporting platforms to provide remote-sensing satellite data receiving services across the world.

(2) Satellite communications and broadcasting system. This system is oriented toward industrial and market applications, and mainly operates through business models while meeting public welfare needs. China will develop both fixed and mobile communications and broadcasting as well as data relay satellites, build a space-ground integrated information network consisting of space-based systems such as high-earth-orbit broadband satellite systems and low-earth-orbit mobile satellite systems, and ground-based systems such as satellite-access stations. TT&C stations, gateway stations, uplink stations, calibration fields and other satellite ground facilities are to be built synchronously. These efforts are expected to bring about a comprehensive system capable of providing broadband communications, fixed communications, direct-broadcast television, mobile communications and mobile multimedia broadcast services. A global satellite communications and broadcasting system integrated with the ground communications network will be established step by step.

(3) Satellite navigation system. China is to continuously enhance the service capacities of the Beidou-2. With sustained efforts in building the Beidou global system, we plan to start providing basic services to countries along the Silk Road Economic Belt and 21st-century Maritime Silk Road in 2018, form a network consisting of 35 satellites for global services by 2020, and provide all clients with more accurate and more reliable services through advancing the ground-based and satellite-based augmentation systems in an integrated way.

3. Manned spaceflight

China plans to launch the Tianzhou-1 cargo spacecraft to dock with the earth-orbiting Tiangong-2 space laboratory, and research and master key technologies for cargo transport and replenishment to accumulate experience in building and operating a space station.

We aim to complete the main research and development work on the space station modules, and start assembly and operation of the space station.

We strive to acquire key technologies and conduct experiments on such technologies to raise our manned spaceflight capacity, laying a foundation for exploring and developing cislunar space.

4. Deep-space exploration

China will continue its lunar exploration project, and strive to attain the automated extraterrestrial sampling and returning technology by space explorers. We plan to fulfill the three strategic steps of "orbiting, landing and returning" for the lunar exploration project by launching the Chang' e-5 lunar probe by the end of 2017 and realizing regional soft landing, sampling and return. We will launch the Chang'e-4 lunar probe around 2018 to achieve mankind' s first soft landing on the far side of the moon, and conduct in situ and roving detection and relay communications at earth-moon L2 point. Through the lunar exploration project, topographic and geological surveys will be implemented and laboratory research conducted on lunar samples; geological survey and research as well as low-frequency radio astronomy observation and research will be carried out targeting the landing area on the far side of the moon for a better understanding of the formation and evolution of the moon.

China intends to execute its first Mars exploration operation, and grasp key technologies for orbiting, landing and roving exploration. It plans to launch the first Mars probe by 2020 to carry out orbiting and roving exploration. It will conduct further studies and key technological research on the bringing back of samples from Mars, asteroid exploration, exploration of the Jupiter system and planet fly-by exploration. When conditions allow, related projects will be implemented to conduct research into major scientific questions such as the origin and evolution of the solar system, and search for extraterrestrial life.

5. Experiments on new space technologies

China is to perform experiments on new space technologies to provide solid technological support for its space industry.

China will develop and launch technology experiment satellites, including the Shijian-13, Shijian-17 and Shijian-18, and a global carbon dioxide monitoring satellite, and conduct experiments on key technologies for new electric propulsion, laser communications and common platforms of new-generation communications satellites. It plans to build in-orbit servicing and maintenance systems for spacecraft and make in-orbit experiments on new theories, technologies and products by tapping various resources.

6. Space launch sites

China will improve its existing space launch sites by raising the reliability and IT application level and conducting adaptive improvements to ground facilities and equipment, and increasing the complementarity of mission enforcement and backup capacities of space launch sites, equipping them with basic capacities to carry out various launch missions. It will explore and advance the building of space launch sites that are open to cooperation and sharing, form a new space launch system featuring rational division of work, mutual complementarity, smooth coordination, security and reliability. The integrated capacities and functions of space launch sites will be enhanced and exploited to meet various needs.

7. Space TT&C

China will enhance its existing space TT&C systems. It aims to build and operate a second-generation relay satellite system, raise the accuracy of the orbit determination process for spacecraft, improve its TT&C capabilities in managing in-orbit spacecraft, and strengthen integrated and efficient utilization of TT&C resources, to build a space-ground integrated TT&C network featuring security, reliability, quick response, flexible access, efficient operation and diverse services. It plans to explore the development of commercial TT&C systems, seek new service modes, and intensify international cooperation and networking in the field of TT&C, forming a new TT&C service pattern marked by openness and sharing.

8. Space applications

China will improve its space application service system oriented toward industries, regions and the public, expand integrated application of space information, and improve the application and marketing of scientific and technological results. Consequently, the scale, operational standards and industrialization level of space applications will be raised to serve national security and national economic and social development.

(1) Industrial applications. In view of the need for global land surveying and geographic information acquisition, resource development and environmental protection, maritime development and management, and the protection of related rights and interests, natural disaster prevention and reduction and emergency response, global climate change control, food security, social management and public services, China plans to consolidate the integrated application of space infrastructure, and enhance its ability to provide timely, accurate and steady services.

(2) Regional applications. In view of the need for regional urban planning, construction, operation management and social services, China will develop comprehensive satellite applications, such as new urbanization layout, and smart towns and smart transport applications, to serve the coordinated development of the eastern, central, western, northeastern parts of the country, collaborated development of Beijing, Tianjin and Hebei, building of the Yangtze River Economic Belt, and economic and social development of other regions in China. In addition, China will intensify its services oriented toward the nationally targeted poverty alleviation and eradication, and operate space information services targeting old revolutionary base areas, ethnic minorities regions, frontier areas, poverty-stricken areas and islands in the sea.

(3) Public services. Aiming at public information consumption and services, including smart tourism, broadcasting and TV, distance learning, telemedicine, and cultural communication, China is determined to develop smart terminals of satellite applications and wearable electronics, improve space information fusion applications, and advance the industrialization of space applications, fostering new growth points for the national economy.

9. Space science

Targeting major frontier areas of space science and technology, China will implement a series of new space science satellite programs, establish a series of space science satellites featuring sustainable development, and reinforce basic application research. Major discoveries and breakthroughs are expected in the frontier areas of space science to further mankind's knowledge of the universe.

(1) Space astronomy and space physics. China will seek evidence of the existence of dark matter by using dark matter particle exploration satellites to detect high-energy electrons and high-energy gamma rays in the universe. It plans to launch a hard X-ray modulation telescope to study the matter dynamics and high-energy radiation processes in the strong gravitational field of compact celestial bodies and black holes. Relevant resources will be brought into play for research into large-scale structure and interaction models of solar wind and the magnetosphere, and response to magnetospheric substorm change process.

(2) Scientific experiments in space. The Shijian-10 recoverable satellite, Chang'e probes, Shenzhou spacecraft, Tiangong-2 space laboratory and Tianzhou-1 cargo spacecraft are to be used to implement scientific experiments and research in biology, life sciences, medicine and materials in the space environment.

(3) Quantum experiments in space. Quantum experiment satellites are to be used to conduct experiments and research in the fields of quantum key transmission, quantum entanglement distribution, and quantum teleportation.

(4) Basic and applied research. China will carry out basic research into sun-earth space environment, space climate, and solar activity and its impact on space climate, and implement space-related interdisciplinary research as well. Comprehensive techniques will be developed for analyzing data from space observations on the properties of X-rays, the energy spectrum and spatial distribution of high-energy electrons and high-energy gamma rays, space physics, extraterrestrial celestial bodies, and the earth's electromagnetic field and ionosphere, to promote the application of space research findings.

10. Space environment

China will improve the standardization system for space debris, near-earth objects and space climate. It will enhance the space debris basic database and data-sharing model, and advance the development of space debris monitoring facilities, the early warning and emergency response platform and the online service system, through reinforcing integrated utilization of resources. The protection systems of spacecraft will be further strengthened. Furthermore, efforts will be made to improve the space environment monitoring system and to build a disaster early warning and prediction platform to raise our preventative capability. It will conduct studies on the building of facilities for monitoring near-earth objects, and put the plan into operation to elevate our capability to monitor and catalog such objects.

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IV. Policies and Measures for Development

The Chinese government has formulated policies and measures to support the space industry and create favorable conditions for its sustainable, sound and rapid development.

The China National Space Administration is the government agency in charge of China's civil space activities and international space cooperation, and performs corresponding functions of administration.

1. Space activities rationally arranged

Priority is given to the construction and application of space infrastructure, alongside support for space exploration and space science research, in China's ongoing efforts to expand its capacity to enter and utilize space and enhance guarantee for space security.

2. Space innovation greatly enhanced

A number of major projects and scientific and technological programs have been implemented to promote significant progress of space science and technology, and enhance the overall level of China's science and technology.

The roles of various players are clearly defined in the formation of a framework of innovation featuring the coordinated efforts of the government, enterprises, universities, research institutions and consumers, and the creation of technical and industrial innovation partnerships, so as to shape a chain of innovation to match the overall industrial chain.

Efforts are being made to build a space research base and plan in advance strategic, fundamental and forward-looking research projects to tackle key technical problems, so as to substantially increase China's capacity for original innovation and create a state-of-art platform in this field.

The customization development of space technologies has been enhanced to put research findings into industrial production and lead national economic development.

3. Space industry capacity transformed and upgraded

Efforts are constantly being made to build an integrated and open system comprising system integrators, specialized contractors, market suppliers and public service providers, based on the national economy and covering all links from scientific research to production.

A project to reinforce space science infrastructure has got off the ground with the goal of removing the basic bottlenecks and obstacles concerning key materials, core spare parts and advanced technology, and improving such systems as standards and measurements.

Information technology has been further applied to make space industry capacity more digitalized, Internet- and artificial intelligence-based.

4. Satellite application industry accelerated

Industrial policies related to satellite application, and national standards and quality systems have been improved. Supportive mechanisms for satellite data sharing have been established and improved, and platforms for sharing satellite data and resources upgraded to create a satisfactory environment for the satellite application industry and boost the overall performance of satellite application.

Industrial clusters and markets for satellite application are being cultivated to improve the industrial chain. Development for

integration application of satellite technologies is being encouraged to promote the integrated development of satellite application with the Internet, big data, Internet of Things and other emerging industries, so as to create new products, new technologies, new modes of business and new points of growth, and give impetus to the mass entrepreneurship and innovation.

5. Relevant legislative work strengthened

Efforts have been made to accelerate the formation of a legal system centering on the legislation of a national law to govern the space industry, including studying and formulating regulations on space data and their application management, the management of the export of astronautic products and technologies. The regulations in force on permits for space launch projects, registration of space-related items, and permits for scientific and technological research and production have been improved to guide and regulate various space-related activities in accordance with the law, which provides legal guarantee for building China's space industry.

China has undertaken studies of international space law, and actively participated in the formulation of international rules regarding outer space.

6. System of diverse funding improved

The scope of government investment is being clearly specified, the way in which such investment is arranged is optimized and investment management is regulated, and sustainable and steady government financial support for space activities is guaranteed.

The mechanism for market access and withdrawal has been improved. A list of investment projects in the space industry has been introduced for better management in this regard. Non-governmental capital and other social sectors are encouraged to participate in space-related activities, including scientific research and production, space infrastructure, space information products and services, and use of satellites to increase the level of commercialization of the space industry.

The government has increased its cooperation with private investors, and the mechanism for government procurement of astronautic products and services has been improved.

7. Training of professionals for the space industry strengthened

The mechanisms related to the training, assessment, flow of and incentives for professional personnel are being improved in an effort to form a well-structured contingent of highly qualified personnel in the course of construction of important projects and major programs, which consists of strategic scientists, leading researchers and technicians, entrepreneurs and high-caliber professionals, as well as experts in international cooperation.

8. Knowledge about space science disseminated

Events have been organized around "China Space Day," "World Space Week" and "Science and Technology Week" to disseminate knowledge and culture about space, promote the "Spirit of the Manned Space Program," inspire the nation, especially its young people, to develop an interest in science, explore the unknown and make innovations, and attract more people into China's space industry.

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V. International Exchanges and Cooperation

The Chinese government holds that all countries in the world have equal rights to peacefully explore, develop and utilize outer space and its celestial bodies, and that all countries' outer space activities should be beneficial to their economic development and social progress, and to the peace, security, survival and development of mankind.

International space cooperation should adhere to the fundamental principles stated in the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, and the Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interests of All States, Taking into Particular Account the Needs of Developing Countries. China maintains that international exchanges and cooperation should be strengthened on the basis of equality and mutual benefit, peaceful utilization and inclusive development.

1. Fundamental policies

The Chinese government has adopted the following fundamental policies with regard to international space exchanges and cooperation:

- Supporting activities regarding the peaceful use of outer space within the framework of the United Nations;

- Supporting all inter-governmental and non-governmental space organizations' activities that promote development of the space industry;

- Strengthening bilateral and multilateral cooperation which is based on common goals and serves the Belt and Road Initiative;

- Supporting the Asia-Pacific Space Cooperation Organization to play an important role in regional space cooperation, and attaching importance to space cooperation under the BRICS cooperation mechanism and within the framework of the Shanghai Cooperation Organization.

- Encouraging and endorsing the efforts of domestic scientific research institutes, industrial enterprises, institutions of higher learning and social organizations to develop international space exchanges and cooperation in diverse forms and at various levels under the guidance of relevant state policies, laws and regulations.

2. Major events

Since 2011 China has signed 43 space cooperation agreements or memoranda of understanding with 29 countries, space agencies and international organizations. It has taken part in relevant activities sponsored by the United Nations and other relevant international organizations, and supported international commercial cooperation in space. These measures have yielded fruitful results.

(1) Bilateral cooperation

- China and Russia signed the Outline of China-Russia Space Cooperation from 2013 to 2017 through the mechanism of the Space Cooperation Sub-committee during the Prime Ministers' Meeting between Russia and China. The two countries have actively promoted cooperation in deep space exploration, manned spaceflight, earth observation, satellite navigation, space-related electronic parts and components, and other areas.

- China and the European Space Agency (ESA) signed the Outline of China-ESA Space Cooperation from 2015 to 2020 within the mechanism of the China-Europe Joint Commission on Space Cooperation. The two sides have declared their determination to cooperate in deep space exploration, space science, earth observation, TT&C services, space debris, and space-related education and training, and launched the panoramic imaging satellite for solar wind and magnetosphere interaction. The two

sides have completed cooperation on the Dragon 3 cooperation program.

- China and Brazil, through the mechanism of the Space Cooperation Sub-committee of the Sino-Brazilian High-level Coordination Commission, have conducted constant cooperation in the China-Brazil Earth Resources Satellite (CBERS) program. They successfully launched CBERS-4, signed the Supplementary Agreement of China and Brazil on the Joint Development of CBERS-04A and Cooperation Agreement of China and Brazil on Remote-Sensing Satellite Data and Application, maintaining CBERS data consistency. The two countries also updated CBERS data receiving stations in South Africa and Singapore, expanding CBERS data application regionally and globally. They have worked together to set up the China-Brazil Joint Laboratory for Space Weather.

- China and France, within the mechanism of the Sino-French Joint Commission on Space Cooperation, have engaged in bilateral cooperation on astronomic, ocean and other satellite programs. The two countries have signed a letter of intent on space and climate change, and worked to promote the application of space technology in global climate change governance.

- China and Italy set up the Sino-Italian Joint Commission on Space Cooperation, and have steadily carried forward research and development of the China-Italy Electromagnetic Monitoring Experiment Satellite Program.

- China and Britain have promoted construction of a joint laboratory on space science and technology, upgraded their exchanges in space science and technology personnel, and launched cooperative studies on remote-sensing applications.

- China and Germany have promoted dialogue between their space industry enterprises, and strengthened cooperation in high-end space manufacturing.

- China and the Netherlands signed a memorandum of understanding on space cooperation, promoting cooperation in remote-sensing applications in agriculture, water resources and atmospheric environment, and stating that Chang'e-4 would carry a Dutch payload in its mission.

- China and the United States, within the framework of the China-U.S. Strategic and Economic Dialogue, carried out a civil space dialogue, stating that the two countries would strengthen cooperation in space debris, space weather, response to global climate change, and related areas.

- China signed space cooperation agreements and established bilateral space cooperation mechanisms with Algeria, Argentina, Belgium, India, Indonesia, Kazakhstan to strengthen exchanges and cooperation in such areas as space technology, space applications, and space science, education and training.

(2) Multilateral cooperation

- China takes an active part in activities organized by the United Nations Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Sub-committee and Legal Sub-committee, and negotiations on international space rules such as the long-term sustainability of outer space activities. It signed the Memorandum of Understanding between the China National Space Administration and the United Nations on Earth Observation Data and Technical Support, actively promoting data sharing and cooperation between China's earth observation satellites on the UN platform.

- China supports the relevant work of the Beijing office of the United Nations Platform for Space-based Information for Disaster Management and Emergency Response. The UN set up the Regional Center for Space Science and Technology Education in Asia and the Pacific (China) in Beijing to promote personnel training in the international space arena.

- Within the framework of the Asia-Pacific Space Cooperation Organization (APSCO), China actively participated in the APSCO Joint Small Multi-mission Satellite Constellation Program. It also organized the APSCO Development Strategy Forum with the theme of "the Belt and Road Initiative for Facilitating Regional Capacity Building of the Asia-Pacific Countries," at which the Beijing Declaration was adopted.

- China and the space agencies of Brazil, Russia, India, and South Africa co-sponsored and actively promoted cooperation in the BRICS remote-sensing satellite constellation.

- China launched the China-ASEAN Satellite Information Maritime Application Center, and Lancang-Mekong River Spatial Information Exchange Center.

- China actively participated in activities organized by the Inter-Agency Space Debris Coordination Committee (IADC), International Charter on Space and Major Disasters, Group on Earth Observations, and other intergovernmental organizations. It hosted the 31st Council of the International Charter on Space and Major Disasters, the 32nd Meeting of the IADC and other international conferences.

- China actively participated in activities organized by the International Committee on Global Navigation Satellite Systems (ICG) and held the Seventh ICG Conference. It actively improved the compatibility and interoperability of the Beidou system with

other satellite navigation systems, popularized satellite navigation technology, and cooperated with a number of countries and regions in satellite navigation applications.

- China actively participated in activities organized by the International Astronautical Federation, International Committee on Space Research, International Academy of Astronautics, International Institute of Space Law, and other non-governmental international space organizations and academic institutes. It held the 64th International Astronautical Congress, 2014 United Nations / China / APSCO Workshop on Space Law, 36th International Conference on Earth Science and Remote-Sensing, and related international conferences. It also held the First Seminar on Manned Spaceflight Technology within the framework of the United Nations Program on Space Applications.

- China actively participated in the international coordination of global disaster prevention and reduction, and provided satellite data support and technical services for major international disaster-relief efforts through the United Nations Platform for Space-based Information on Disaster Management and Emergency Response, United Nations Economic and Social Commission for Asia and the Pacific, International Charter on Space and Major Disasters, and related mechanisms.

(3) Commercial activities

China encourages and supports Chinese enterprises to participate in international commercial activities in the space field. It has exported satellites and made in-orbit delivery of Nigeria's communications satellite, Venezuela's remote-sensing satellite-1, Bolivia's communications satellite, Laos' communications satellite-1 and Belarus' communications satellite-1. In addition, it provided commercial launch service for Turkey's Gokturk-2 earth observation satellite, and when launching its own satellites took on small satellites for Ecuador, Argentina, Poland, Luxembourg and other countries. It has also provided business services concerning space information.

3. Key areas for future cooperation

In the next five years China will, with a more active and open attitude, conduct extensive international exchanges and cooperation concerning space in the following key areas:

- Construction of the Belt and Road Initiative Space Information Corridor, including earth observation, communications and broadcasting, navigation and positioning, and other types of satellite-related development; ground and application system construction; and application product development.

- Construction of the BRICS remote-sensing satellite constellation.

- Construction of the APSCO Joint Small Multi-mission Satellite Constellation Program and University Small Satellite Project Development.

- The Moon, Mars and other deep space exploration programs and technical cooperation.

- Inclusion of a space laboratory and a space station in China's manned spaceflight program.

- Research and development of a space science satellite, a remote-sensing satellite, payloads, etc.

- Construction of ground infrastructure such as data receiving stations and communications gateway stations.

- Satellite applications, including earth observation, communications and broadcasting, navigation and positioning.

- Exploration and research on space science.

- Launching and carrying services.

- Space TT&C support.

- Space debris monitoring, early warning, mitigation and protection.

- Space weather cooperation.

- Import and export of and technical cooperation in the field of whole satellites, sub-systems, spare parts and electronic components of satellites and launch vehicles, ground facilities and equipment, and related items.

- Research on space law, policy and standards.

- Personnel exchanges and training in the space field.

Conclusion

In the present-day world, more and more countries are attaching importance to and taking an active part in developing space activities. Moreover, space technology is being widely applied in all aspects of our daily life, exerting a major and far-reaching influence on social production and lifestyle.

It is mankind's unremitting pursuit to peacefully explore and utilize outer space. Standing at a new historical starting line, China is determined to quicken the pace of developing its space industry, and actively carry out international space exchanges and cooperation, so that achievements in space activities will serve and improve the well-being of mankind in a wider scope, at a deeper level and with higher standards. China will promote the lofty cause of peace and development together with other countries.

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