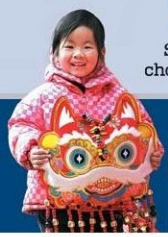

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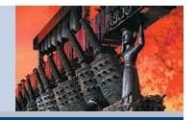

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China's Space Program: A 2021 Perspective

The State Council Information Office published a white paper on Friday to introduce China's goals, principles, policies and measures, and cooperative mindset in its exploration of the cosmos. Following is the full text:

Preamble

"To explore the vast cosmos, develop the space industry and build China into a space power is our eternal dream," stated Chinese President Xi Jinping. The space industry is a critical element of the overall national strategy, and China upholds the principle of exploration and utilization of outer space for peaceful purposes.

Since 2016, China's space industry has made rapid and innovative progress, manifested by a steady improvement in space infrastructure, the completion and operation of the BeiDou Navigation Satellite System, the completion of the high-resolution Earth observation system, steady improvement of the service ability of satellite communications and broadcasting, the conclusion of the last step of the three-step lunar exploration program ("orbit, land, and return"), the first stages in building the space station, and a smooth interplanetary voyage and landing beyond the Earth-moon system by Tianwen-1, followed by the exploration of Mars. These achievements have attracted worldwide attention.

In the next five years, China will integrate space science, technology and applications while pursuing the new development philosophy, building a new development model and meeting the requirements for high-quality development. It will start a new journey toward becoming a space power. The space industry will contribute more to China's growth as a whole, to global consensus and common effort with regard to outer space exploration and utilization, and to human progress.

We are publishing this white paper to offer a brief introduction to China's major achievements in this field since 2016 and its main tasks in the next five years, in order to help the international community better understand China's space industry.

I. A New Journey toward a Strong Space Presence

1. Mission

The mission of China's space program is: to explore outer space to expand humanity's understanding of the Earth and the cosmos; to facilitate global consensus on our shared responsibility in utilizing outer space for peaceful purposes and safeguarding its security for the benefit of all humanity; to meet the demands of economic, scientific and technological development, national security and social progress; and to raise the scientific and cultural levels of the Chinese people, protect China's national rights and interests, and build up its overall strength.

2. Vision

China aims to strengthen its space presence in an all-around manner: to enhance its capacity to better understand, freely access, efficiently use, and effectively manage space; to defend national security, lead self-reliance and self-improvement efforts in science and technology, and promote high-quality economic and social development; to advocate sound and efficient governance of outer space, and pioneer human progress; and to make a positive contribution to China's socialist modernization and to peace and progress for all humanity.

3. Principles

China's space industry is subject to and serves the overall national strategy. China adheres to the principles of innovation-driven, coordinated, efficient, and peaceful progress based on cooperation and sharing to ensure a high-quality space industry.

• Innovation-driven development

China puts innovation at the core of its space industry. It boosts state strategic scientific and technological strength in the space industry, implements major space programs, strengthens original innovation, optimizes the environment for innovation, achieves industrial production as early as possible, and grows China's independent capacity to build a safe space industry.

• Coordination and efficiency

China adopts a holistic approach in building its space industry. It mobilizes and guides different sectors to take part in and contribute to this key industry, and coordinates all relevant activities under an overall plan. It ensures that technology plays a greater role in promoting and guiding space science and applications, and it facilitates the growth of new forms and models of business for the industry. These measures aim to raise the quality and overall performance of China's space industry.

• For peaceful purposes

China has always advocated the use of outer space for peaceful purposes, and opposes any attempt to turn outer space into a weapon or battlefield or launch an arms race in outer space. China develops and utilizes space resources in a prudent manner, takes effective measures to protect the space environment, ensures that space remains peaceful and clean, and guarantees that its space activities benefit humanity.

• Cooperation and sharing

China always combines independence and self-reliance with opening to the outside world. It actively engages in high-level international exchanges and cooperation, and expands global public services for space technology and products. It takes an active part in solving major challenges facing humanity, helps to realize the goals of the United Nations 2030 Agenda for Sustainable Development, and facilitates global consensus and common effort with regard to outer space exploration and utilization.

II. Development of Space Technology and Systems

China's space industry serves its major strategic needs, and targets cutting-edge technology that leads the world. Spearheaded by the major space projects, the country has accelerated research into core technologies, stepped up their application, and redoubled its efforts to develop space technology and systems. As a result, China's capacity to enter and return from space, and its ability to engage in space exploration, utilization and governance have grown markedly along a sustainable path.

1. Space Transport System

From 2016 to December 2021, 207 launch missions were completed, including 183 by the Long March carrier rocket series. The total launch attempts exceeded 400.

The Long March carrier rockets are being upgraded toward nontoxic and pollution-free launch, and they are becoming smarter boosted by modular technology. The Long March-5 and Long March-5B carrier rockets have been employed for regular launches; Long March-8 and Long March-7A have made their maiden flights, with increased payload capacity.

China now provides a variety of launch vehicle services. The Long March-11 carrier rocket has achieved commercial launch from the sea; the Smart Dragon-1, Kuaizhou-1A, Hyperbola-1, CERES-1 and other commercial vehicles have been successfully launched; successful demonstration flight tests on reusable launch vehicles have been carried out.

In the next five years, China will continue to improve the capacity and performance of its space transport system, and move faster to upgrade launch vehicles. It will further expand the launch vehicle family, send into space new-generation manned carrier rockets and high-thrust solid-fuel carrier rockets, and speed up the R&D of heavy-lift launch vehicles. It will continue to strengthen research into key technologies for reusable space transport systems, and conduct test flights accordingly. In response to the growing need for regular launches, China will develop new rocket engines, combined cycle propulsion, and upper stage technologies to improve its capacity to enter and return from space, and make space entry and exit more efficient.

2. Space Infrastructure

(1) Satellite remote-sensing system

The space-based section of the China High-resolution Earth Observation System has been largely completed, enabling high-spatial-resolution, high-temporal-resolution and high-spectrum-resolution Earth observation. China now provides improved land observation services, having launched the Ziyuan-3 03 Earth resources satellite, the Huanjing Jianzai-2A/2B satellites for environmental disaster management, a high-resolution multi-mode imaging satellite, a hyperspectral observation satellite, and a number of commercial remote-sensing satellites.

In ocean observation, China is now able to view multiple indexes of contiguous waters around the globe on all scales, with high-resolution images from the Haiyang-1C/1D satellites and the Haiyang-2B/2C/2D satellites.

China's ability to observe the global atmosphere has achieved a significant increase. Its new-generation Fengyun-4A/4B meteorological satellites in the geostationary orbit are able to perform all-weather, precise and uninterrupted atmospheric monitoring and disaster monitoring to boost response capability. The successful launches of Fengyun-3D/3E satellites enable coordinated morning, afternoon and twilight monitoring, and the Fengyun-2H satellite provides monitoring services for countries and regions participating in the Belt and Road Initiative.

With further improvements to the ground system of its remote-sensing satellites, China is now able to provide remote-sensing satellite data receiving and quick processing services across the world.

(2) Satellite communications and broadcasting system

China has made steady progress in developing fixed communications and broadcasting satellite network, which now covers more areas with greater capacity. The Zhongxing-6C and Zhongxing-9B satellites ensure the uninterrupted, stable operation of broadcasting and television services. The Zhongxing-16 and APSTAR-6D satellites, each with a 50Gbps capacity, signify that satellite communications in China have reached the stage of high-capacity service.

The mobile communications and broadcasting satellite network has expanded with the launch of the Tiantong-1 02/03 satellites, operating in tandem with the Tiantong-1 01 satellite, to provide voice, short message and data services for hand-held terminal users in China, its neighboring areas, and certain parts of the Asia-Pacific.

The relay satellite system is being upgraded with the launch of the Tianlian-1 05 and Tianlian-2 01 satellites, giving a powerful boost to capacity.

The satellite communications and broadcasting ground system has been improved, to form a space-ground integrated network that provides satellite communications and broadcasting, internet, Internet of Things, and information services around the globe.

(3) Satellite navigation system

The completion and operation of the 30-satellite BeiDou Navigation Satellite System (BDS-3) represents the successful conclusion of the system's three-step strategy and its capacity to serve the world. BeiDou's world-leading services include positioning, navigation, timing, regional and global short-message communication, global search and rescue, ground-based and satellite-based augmentation, and precise point positioning.

In the next five years, China will continue to improve its space infrastructure, and integrate remote-sensing, communications, navigation, and positioning satellite technologies. It will:

Upgrade its spatial information services featuring extensive connection, precise timing and positioning, and all dimension sensoring;

Develop satellites for geostationary microwave monitoring, new-type ocean color observation, carbon monitoring of the territorial ecosystem, and atmospheric environmental monitoring;

Develop dual-antenna X-band interferometric synthetic aperture radar (InSAR), land water resources and other satellite technology, for efficient, comprehensive Earth observation and data acquisition across the globe;

Build a satellite communications network with high and low orbit coordination, test new communications satellites for commercial application, and build a second-generation data relay satellite system;

Study and research navigation-communications integration, low-orbit augmentation and other key technologies for the next-generation BeiDou Navigation Satellite System, and develop a more extensive, more integrated and smarter national positioning, navigation and timing (PNT) system;

Continue to improve the ground systems for remote-sensing, communications and navigation satellites.

3. Manned Spaceflight

The Tianzhou-1 cargo spacecraft has docked with the Earth-orbiting Tiangong-2 space laboratory. With breakthroughs in key technologies for cargo transport and in-orbit propellant replenishment, China has successfully completed the second phase of its manned spaceflight project.

The launch of the Tianhe core module marks a solid step in building China's space station. The Tianzhou-2 and Tianzhou-3 cargo spacecraft and the Shenzhou-12 and Shenzhou-13 manned spacecraft, together with the Tianhe core module to which they have docked, form an assembly in steady operation. Six astronauts have worked in China's space station, performing extravehicular activities, in-orbit maintenance, and scientific experiments.

In the next five years, China will continue to implement its manned spaceflight project. It plans to:

Launch the Wentian and Mengtian experimental modules, the Xuntian space telescope, the Shenzhou manned spacecraft, and the Tianzhou cargo spacecraft;

Complete China's space station and continue operations, build a space laboratory on board, and have astronauts on long-term assignments performing large-scale scientific experiments and maintenance;

Continue studies and research on the plan for a human lunar landing, develop new-generation manned spacecraft, and research key technologies to lay a foundation for exploring and developing cislunar space.

4. Deep Space Exploration

(1) Lunar exploration

Achieving relay communications through the Queqiao satellite, the Chang'e-4 lunar probe performed humanity's first soft landing on the far side of the moon, and conducted roving exploration. The Chang'e-5 lunar probe brought back 1,731 g of samples from the moon, marking China's first successful extraterrestrial sampling and return, and the completion of its three-step lunar exploration program of orbiting, landing and return.

(2) Planetary exploration

The Tianwen-1 Mars probe orbited and landed on Mars; the Zhurong Mars rover explored the planet and left China's first mark there. China has achieved a leap from cislunar to interplanetary exploration.

In the next five years, China will continue with lunar and planetary exploration. It will:

Launch the Chang'e-6 lunar probe to collect and bring back samples from the polar regions of the moon;

Launch the Chang'e-7 lunar probe to perform a precise landing in the moon's polar regions and a hopping detection in lunar shadowed area;

Complete R&D on the key technology of Chang'e-8, and work with other countries, international organizations and partners to build an international research station on the moon;

Launch asteroid probes to sample near-Earth asteroids and probe main-belt comets;

Complete key technological research on Mars sampling and return, exploration of the Jupiter system, and so forth;

Study plans for boundary exploration of the solar system.

5. Space Launch Sites and Telemetry, Tracking and Command (TT&C)

(1) Space launch sites

Adaptive improvements have been completed at the Jiuquan, Taiyuan and Xichang launch sites, with new launchpads installed at Jiuquan for the commercial launch of liquid fuel rockets, and the Wenchang Launch Site entering service. China has formed 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 station modules, deep space probes and all kinds of satellites. In addition, its first sea launch site has begun operation.

(2) Space TT&C

China's leap from cislunar to interplanetary TT&C communications, with growing space-based TT&C capacity, represents a significant progress. Its space TT&C network has improved to form an integrated space-ground TT&C network providing security, reliability, quick response, flexible access, efficient operation and diverse services. TT&C missions of the Shenzhou and Tianzhou spacecraft series, Tianhe core module, Chang'e lunar probe series, and Tianwen-1 Mars probe have been completed successfully. TT&C station networks for commercial satellites are growing quickly.

In the next five years, China will strengthen unified technical standard-setting for its space products, and on this basis will:

Further adapt the existing launch site system to better serve most launch missions, and make launch sites smarter, more reliable and more cost-effective to support high-intensity and diversified launch missions;

Build commercial launchpads and launch sites to meet different commercial launch needs;

Improve the space TT&C network in terms of organization, technology and methodology, grow the capacity to utilize and integrate space- and ground-based TT&C resources, and build a space TT&C network providing ubiquitous coverage and connections;

Coordinate the operation and management of the national space system for greater efficiency;

Strengthen the deep-space TT&C communications network to support missions probing the moon and Mars.

6. Experiments on New Technologies

China has launched a number of new technological test satellites, and tested new technologies such as the common platforms of new-generation communications satellites, very high throughput satellites' telecommunication payload, Ka-band communications, satellite-ground high-speed laser communications, and new electric propulsion.

In the next five years, China will focus on new technology engineering and application, conduct in-orbit tests of new space materials, devices and techniques, and test new technologies in these areas:

Smart self-management of spacecraft;

Space mission extension vehicle;

Innovative space propulsion;

In-orbit service and maintenance of spacecraft;

Space debris cleaning.

7. Space Environment Governance

With a growing database, China's space debris monitoring system is becoming more capable of collision warning and space event perception and response, effectively ensuring the safety of in-orbit spacecraft.

In compliance with the Space Debris Mitigation Guidelines and the Guidelines for the Long-term Sustainability of Outer Space Activities, China has applied upper stage passivation to all its carrier rockets, and completed end of life active deorbit of the Tiangong-2 and other spacecraft, making a positive contribution to mitigating space debris.

Progress has been made in the search and tracking of near-Earth objects and in data analysis. A basic space climate service system is now in place, capable of providing services in space climate monitoring, early warning, and forecasting, and is providing broader applications.

In the next five years, China will continue to expand its space environment governance system. It will:

Strengthen space traffic control;

Improve its space debris monitoring system, cataloging database, and early warning services;

Conduct in-orbit maintenance of spacecraft, collision avoidance and control, and space debris mitigation, to ensure the safe, stable and orderly operation of the space system;

Strengthen the protection of its space activities, assets and other interests by boosting capacity in disaster backup and information protection, and increasing invulnerability and survivability;

Study plans for building a near-Earth object defense system, and increase the capacity of near-Earth object monitoring, cataloging, early warning, and response;

Build an integrated space-ground space climate monitoring system, and continue to improve relevant services to effectively respond to catastrophic space climate events.

III. Developing and Expanding Space Application Industry

To serve the economy and society, China has promoted public and commercial application of its satellites and space technology, growing the industry toward greater efficiency.

1. Boosting Public Services with Satellites

The service capacity of satellite applications has markedly improved. The significant role of satellites is seen in the protection of resources and the eco-environment, disaster prevention and mitigation, management of emergencies, weather forecasting and climate change response, and also felt in social management and public services, urbanization, coordinated regional development, and poverty eradication. The space industry helps to improve people's lives.

The satellite remote-sensing system has been used by almost all departments at national and provincial levels to conduct emergency monitoring of over 100 major and catastrophic natural disasters around the country. It provides services to tens of thousands of domestic users and over 100 countries, having distributed over 100 million scenes of data.

The communications and broadcasting satellite network has made direct services available to over 140 million households in China's rural and remote areas, provided returned data for over 500 mobile phone base stations, and ensured efficient emergency communications during the responses to the forest fire in Liangshan, Sichuan province, to the heavy rainstorm in Zhengzhou, Henan province and to other major disaster relief work.

The BeiDou Navigation Satellite System has guaranteed the safety of over seven million operating vehicles, provided positioning and short message communication services to over 40,000 seagoing fishing vessels, and offered precise positioning services for the freighting of supplies and tracking of individual movement for COVID-19 control, and for hospital construction.

In the next five years, under the overarching goal of building a safe, healthy, beautiful and digital China, we will intensify the integration of satellite application with the development of industries and regions, and space information with new-generation information technology such as big data and Internet of Things. We will also extend the integrated application of remote-sensing satellite data on land, ocean and meteorology, advance the construction of infrastructure for integrated application of the BeiDou Navigation Satellite System, satellite communications, and the ground communications network, and improve our capacity to tailor and refine professional services. All these efforts will help to achieve the goals of peaking carbon dioxide emissions and carbon neutrality, to revitalize rural areas, and to realize new-type urbanization, coordinated development between regions and eco-environmental progress.

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2. Space Application Industry

The commercial use of satellite technology is thriving, which expands the applications market for governments, enterprises and individuals. A group of competitive commercial space enterprises are emerging and realizing industrialized large-scale operation. A variety of products and services such as high-accuracy maps using remote-sensing data, full dimensional images, data processing, and application software are improving the service to users in transport, e-commerce, trading of agricultural products, assessment of disaster losses and insurance claims, and the registration of real estate.

The ability to commercialize satellite communications and broadcasting services has further improved. Four 4K Ultra HD television channels in China were launched and TV viewers now have access to over 100 HD channels. Internet access is also available on board ocean vessels and passenger aircraft. Tiantong-1, a satellite mobile communication system, is in commercial operation.

The satellite navigation industry has witnessed rapid growth as evidenced by sales of over 100 million chips compatible with the BeiDou system. Its industrial applications have been widely introduced into mass consumption, the sharing economy, and daily life. Achievements in space technology have helped traditional industries transform and upgrade, supported emerging industries such as new energy, new materials and environmental protection, enabled new business models such as smart cities, smart agriculture and unmanned driving to grow, making a great contribution to building China's strengths in science and technology, manufacturing, cyberspace and transport.

In the next five years, China's space industry will seize the opportunities presented by the expanding digital industry and the digital transformation of traditional industries, to promote the application and transfer of space technology. Through innovative business models and the deep integration of space application with digital economy, more efforts will be made to expand and extend the scope for applying satellite remote-sensing and satellite communications technologies, and realizing the industrialized operation of the BeiDou Navigation Satellite System. This will provide more advanced, economical, high-quality products and convenient services for all industries and sectors and for mass consumption. New business models for upscaling the space economy such as travel, biomedicine, debris removal and experiment services will be developed to expand the industry.

IV. Research on Space Science

China's research on space science focuses on scientific questions such as the origin and evolution of the universe, and the relationship between the solar system and humanity. It has launched programs to explore space and conduct experiments, advanced research on basic theories, and incubated major research findings.

1. Research on Space Science

(1) Space astronomy

The Dark Matter Particle Explorer (DAMPE) Satellite obtained the precise measurements of the energy spectra of cosmic ray electrons, protons and the GCR helium. The Huiyan (Insight) Hard X-ray Modulation Telescope was successfully launched; it has since discovered the strongest magnetic field in the universe and obtained a panoramic view of the black hole binary explosion process. The Xihe observation satellite was successfully launched, which obtained multiple solar spectroscopic images at different wavelengths in the H waveband.

(2) Lunar and planetary science

Led by its lunar exploration program, China has achieved significant advances in the comprehensive surveying of the moon's geology and subsurface structure, in dating the lunar magmatic activity, and in analyzing its mineralogical features and chemical elements. In planetary exploration, China has built a deeper understanding of the geological evolution of Mars by conducting analysis of its surface structure and soil and the composition of its rocks.

(3) Space Earth sciences

Zhangheng-1, also known as the China Seismo-Electromagnetic Satellite, helped to obtain data on and build models of the global geomagnetic field and the in situ data of ionosphere parameters. A high-precision global carbon flux map, developed by using the data from the Chinese Global Carbon Dioxide Monitoring Scientific Experimental Satellite, is shared globally free of any charge.

(4) Space physics

With the help of Mozi, the world's first quantum communication satellite, China has carried out experiments on satellite-based quantum teleportation and entanglement distribution over 1,000 kilometers, on gravitational induced decoherence of quantum entanglement, and on entanglement-based secure quantum cryptography over thousand kilometers with no trusted relay. It has also launched the Taiji-1 and Tianqin-1 satellites to support the space gravitational wave detection program.

In the next five years, China will continue with the research and development of programs such as the satellite for space gravitational wave detection, the Einstein Probe, the advanced space-based solar observatory, the panoramic imaging satellite for solar wind and magnetosphere interaction, and the high precision magnetic field measurement satellite, focusing on the subjects of the extreme universe, ripples in time and space, the panoramic view of the sun and the Earth, and the search for habitable planets. China will continue to explore frontier areas and research into space astronomy, heliospheric physics, lunar and planetary science, space Earth sciences, and space physics, to generate more original scientific findings.

2. Science Experiments in Space

With the help of the Shenzhou spacecraft series, the Tiangong-2 space laboratory, and the Shijian-10 satellite, China has achieved mammalian embryonic development in space and in-orbit verification of the world's first space cold atom clock, expanded the understanding of the mechanisms behind particle segregation in microgravity, pulverized coal combustion, and material preparation, and achieved research findings in space science of international standing.

In the coming five years, China will make use of space experiment platforms such as the Tiangong space station, the Chang'e lunar probe series, and the Tianwen-1 Mars probe to conduct experiments and research on biology, life, medicine, and materials, to expand humanity's understanding of basic science.

V. Modernizing Space Governance

The Chinese government has been proactive in developing the space industry, through policy measures and well-thought-out plans for space activities. Better alignment between a well-functioning market and an enabling government gives full play to the roles of both, endeavoring to create a favorable environment for the growth of a high-quality space industry.

1. Enhancing Innovation

In order to create a new configuration in which the upper, middle and lower industrial chains are coordinated, and large, small and medium-sized enterprises advance in an integrated way, China is building a strategic force of space science and technology, encouraging original innovation by research institutes and bringing together enterprises, universities, research institutes and end-users in creating and applying new technologies. A technological innovation alliance is emerging in key areas of space science.

A number of major space and science projects are in place to promote the leapfrog development of space science and technology, which spearheads overall technical advances.

China is making forward-looking plans for strategic, fundamental and technological breakthroughs in space science — it is integrating the application of new-generation information technology in the space sector, and accelerating the engineering application of advanced and especially revolutionary technologies.

The secondary development of space technologies will be further reinforced to put research findings into industrial production and boost the economy.

2. Strengthening Basic Industrial Capabilities

The space industry will continue to improve its integrated and open industrial system comprising system integrators, specialized contractors, market suppliers, and public service providers, and covering all links from research to production.

To strengthen the industrial and supply chains of its space industry and transform and upgrade the basic capabilities of the industry, China will optimize the industrial structure and upgrade R&D, manufacturing, launch operations, and application services, further integrate industrialization with information technology, and build intelligent production lines, workshops and institutes.

3. Expanding Application

China will improve the policies for its satellite application industry, including coordinating public interest and market demand, integrating facilities and resources, unifying data and product standards, and streamline the channel for sharing and utilization. It is committed to improving satellite application services with unified standards and customized choices.

China will move faster to grow its satellite application market, where various market entities are encouraged to develop value-added products. By creating new application models, China is fostering a "space plus" industrial ecosystem and promoting emerging strategic industries related to space.

4. Encouraging Commercialization

China has formulated guidelines on commercializing its space industry. It will expand the scope of government procurement of space products and services, grant relevant enterprises access and sharing rights to major scientific research facilities and equipment, and support these enterprises in joining the R&D of major engineering projects. It will establish a negative list for market access to space activities, to ensure fair competition and the orderly entry and exit of participating enterprises.

China will optimize the distribution of the space industry in the national industrial chain, and encourage and guide participating enterprises to engage in satellite application and the transfer and transformation of space technologies.

5. Promoting Law-Based Governance

To promote law-based governance of the space industry, China will speed up the formulation of a national space law and establish a legal system with this law at the core. This will include studying and formulating regulations on satellite navigation, strengthening the management of satellite navigation activities, revising measures for the registration of space objects, and regulating the sharing and use of space data and the licensing of civil space launches. It will also include studying and formulating regulations on the management of satellite frequency and orbit resources, and strengthening the declaration, coordination and registration of these resources to safeguard the country's legitimate rights and interests in this regard. China has strengthened research on international space law, and actively participated in formulating International Telecommunication Union standards and international rules regarding outer space, maintaining the international order in outer space based on international space law, and contributing to a fair and reasonable global governance system for outer space.

6. Strengthening Team-Building

China will step up its efforts to become a world center for talent and innovation in space science, and create favorable conditions for the development of professionals and the expansion of their ranks. It will improve the personnel training mechanism — fostering a pool of strategic scientists, leading and young scientists, and teams with strong innovation capacity, and cultivating a large number of outstanding engineers, top technicians championing fine craftsmanship, and visionary entrepreneurs with a sense of social responsibility. China will improve its personnel management mechanisms to regulate and guide the rational flow of professionals. It will also upgrade incentives with greater rewards and stronger support, and strengthen specialty disciplines in universities to cultivate a reserve force of aerospace personnel.

7. Promoting Space Education and Culture

China will continue to hold events to celebrate its Space Day, promote education on space knowledge and culture during World Space Week and National Science and Technology Week, and through Tiangong Classroom and other platforms, and promote the culture and spirit embodied in the development of the atomic and hydrogen bombs, missiles, man-made satellites, manned spaceflight, lunar probes and the BeiDou Navigation Satellite System in the new era. The goal is to inspire the nation, especially the young people, to develop an interest in science, to create and explore the unknown, and to increase scientific knowledge among the general public.

China will protect its major space heritage and build more space museums and experience parks to popularize space science and provide education. It will encourage the creation of space-related literary and artworks to promote space culture.

VI. International Cooperation

Peaceful exploration, development and utilization of outer space are rights equally enjoyed by all countries. China calls on all countries to work together to build a global community of shared future and carry out in-depth exchanges and cooperation in outer space on the basis of equality, mutual benefit, peaceful utilization, and inclusive development.

1. Basic Policies

China's basic policies on international exchanges and cooperation are as follows:

Safeguarding the central role of the United Nations in managing outer space affairs; abiding by the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies; upholding the guiding role of relevant UN principles, declarations and resolutions; actively participating in the formulation of international rules regarding outer space; and promoting greater sustainability of space activities;

Strengthening international exchanges and cooperation on space science, technology and application; working together with the international community to provide public products and services; and contributing to global efforts to address common challenges;

Strengthening international space cooperation that is based on common goals and serves the Belt and Road Initiative, and ensuring that the space industry benefits the Initiative's participating countries, especially developing countries;

Supporting the Asia-Pacific Space Cooperation Organization (APSCO) to play an important role, and giving weight to cooperation under the BRICS and Group 20 mechanisms and within the framework of the Shanghai Cooperation Organization;

Encouraging and endorsing the efforts of domestic research institutes, enterprises, institutions of higher learning, and social organizations to engage in international space exchanges and cooperation in diverse forms and at various levels in accordance with relevant policies, laws and regulations.

2. Major Achievements

Since 2016, China has signed 46 space cooperation agreements or memorandums of understanding with 19 countries and regions and four international organizations. It has actively promoted global governance of outer space, and carried out international cooperation in space science, technology and application through bilateral and multilateral mechanisms. These measures have yielded fruitful results.

(1) Global governance of outer space

China participates in consultations on issues such as the long-term sustainability of outer space activities, the development and utilization of space resources, and the prevention of an arms race in outer space. Together with other parties, it has proposed discussions on space exploration and innovation, and advanced the Space2030 Agenda of the UN.

China supports the work of the Beijing office of the United Nations Platform for Space-based Information for Disaster Management and Emergency Response, and has participated in the activities of the International Committee on Global Navigation Satellite Systems in an in-depth manner. It has joined international mechanisms such as the Space Missions Planning Advisory Group and the International Asteroid Warning Network.

China plays its role as the host country of APSCO, and supports the organization's Development Vision 2030.

China has strengthened international exchanges on space debris, long-term sustainability of outer space activities, and other issues through mechanisms such as the Space Debris Work Group of China-Russia Space Cooperation Sub-committee and the Sino-US Expert Workshop on Space Debris and Space Flight Safety.

China supports the activities of international organizations such as the International Telecommunication Union, Group on Earth Observations, Inter-Agency Space Debris Coordination Committee, Consultative Committee for Space Data Systems, International Space Exploration Coordination Group, and the Interagency Operations Advisory Group.

(2) Manned spaceflight

China has carried out gamma-ray burst polarization monitoring research with the European Space Agency on the Tiangong-2 space laboratory, conducted human body medical research in a micro-gravitational environment with France during the Shenzhou-11 manned spaceflight mission, carried out joint CAVES training and maritime rescue drills with the European Astronaut Centre.

China has completed the selection of the first batch of international space science experiments to be conducted on the Chinese space station, and conducted technological cooperation and exchanges with Germany, Italy and Russia on space science experiments and the development of space station sections.

(3) BeiDou Navigation Satellite System

China has coordinated the development of China's BeiDou Navigation Satellite System and the United States' Global Positioning System, Russia's GLONASS system, and Europe's Galileo system. It has carried out in-depth cooperation with them in the fields of compatibility, interoperability, monitoring and assessment, and joint application.

China has pressed ahead with international standardization of the BeiDou system, which has been included in the standard systems of the International Electrotechnical Commission and many other international organizations in fields such as civil aviation, maritime affairs, international search and rescue, and mobile communications.

China has increased the BeiDou system's global service capacity by establishing BeiDou cooperation forum mechanisms with the League of Arab States and the African Union, completing the first overseas BeiDou center in Tunisia, and conducting satellite navigation cooperation with countries such as Pakistan, Saudi Arabia, Argentina, South Africa, Algeria, and Thailand.

(4) Deep-space exploration

China launched the international lunar research station project together with Russia, and initiated the Sino-Russian Joint Data Center for Lunar and Deep-space Exploration. It is working with Russia to coordinate Chang'e-7's lunar polar exploration mission with Russia's LUNA-Resource-1 orbiter mission.

In the Chang'e-4 lunar exploration mission China cooperated with Russia and the European Space Agency on engineering technology, and with Sweden, Germany, the Netherlands and Saudi Arabia on payloads. It has launched international onboard payload cooperation in the Chang'e-6 lunar exploration mission.

In the Tianwen-1 mission, China's first Mars exploration project, China cooperated with the European Space Agency on engineering technology, and with Austria and France on payloads. It has established a Mars probe orbit data exchange mechanism with the United States, and launched international onboard payload cooperation in its asteroid exploration mission.

In the fields of lunar and deep-space exploration, China cooperated on TT&C with the European Space Agency, Argentina, Namibia, and Pakistan.

(5) Space technology

Together with relevant partners China has developed and successfully launched the China-France Oceanography Satellite, China-Brazil Earth Resources Satellite 04A, and the Ethiopian Remote-Sensing Satellite. It has launched the Student Small Satellites (SSS) for APSCO. It is jointly developing the MisrSat-2 remote-sensing satellite.

China completed the in-orbit delivery of the Pakistan Remote-Sensing Satellite (PRSS-1), Venezuelan Remote-Sensing Satellite (VRSS-2), Sudan Remote-Sensing Satellite (SRSS-1), and the Algerian Communications Satellite (Alcomsat-1).

China has provided satellite carrying or launching services for countries including Saudi Arabia, Pakistan, Argentina, Brazil, Canada, and Luxembourg.

China has conducted space product and technology cooperation with countries including Russia, Ukraine, Belarus, Argentina, Pakistan, and Nigeria.

China has helped developing countries boost their space science and research. It has built satellite research and development infrastructure with countries including Egypt, Pakistan and Nigeria. It has pressed ahead with the construction of the Belt and Road Initiative Space Information Corridor, and opened China's space facilities to developing countries.

(6) Space applications

China has established an emergency support mechanism for disaster prevention and mitigation for international users of the Fengyun meteorological satellites, and data from China's meteorological satellites have been widely used in 121 countries and regions.

China has signed cooperation agreements for the BRICS Remote-Sensing Satellite Constellation, cooperated with the European Space Agency on Earth observation satellite data exchange, and built the China-ASEAN Satellite Information Offshore Service Platform and the Remote-Sensing Satellite Data-Sharing Service Platform. It has worked with Laos, Thailand, Cambodia, and Myanmar to build the Lancang-Mekong Space Information Exchange Center.

China has built satellite data receiving stations with countries including Bolivia, Indonesia, Namibia, Thailand and South Africa.

China actively participates in the mechanism of the International Charter on Space and Major Disasters, providing satellite remote-sensing data totaling 800 scenes and adding eight new on-duty satellites (constellations) to the satellite system, thereby improving the international community's capacity for disaster prevention and mitigation.

China actively provides satellite emergency monitoring services. It has initiated emergency monitoring in response to 17 major disasters in 15 countries. For instance, in response to the severe drought in Afghanistan and the dam collapse in Laos in 2018, and to the cyclone that struck Mozambique in 2019, it provided monitoring services for the authorities of affected countries.

China released its GEO Strategic Plan 2016-2025: Implementing GEOSS. It served as the rotating chair of the Group on Earth Observations in 2020 and promoted the construction of a global Earth observation system.

China participates in the international Space Climate Observatory platform, promoting China's best practices in space technology to address climate change, and facilitating international cooperation on space climate observation.

(7) Space science

Using science satellites including Wukong, Mozi, Shijian-10, and Insight, China has conducted joint scientific research and experiments with countries including Switzerland, Italy, Austria, the United Kingdom, and Japan.

China codeveloped and successfully launched the China-Italy Electromagnetic Monitoring Experiment Satellite. It has continued the joint development of the Sino-European Panoramic Imaging Satellite for Solar Wind and Magnetosphere Interaction, Sino-French Astronomic Satellite, and China-Italy Electromagnetic Monitoring Experiment Satellite 02. It has joined countries including Italy and Germany in developing and calibrating the payloads of satellites such as the advanced space-based solar observatory, Einstein Probe, and enhanced X-ray timing and polarimetry observatory.

Using the China-Brazil Joint Laboratory for Space Weather, it co-built the space environment monitoring and research platform for South America.

(8) Personnel and academic exchanges

China has taken part in the activities organized by the International Astronautical Federation, International Committee on Space Research, International Academy of Astronautics, and International Institute of Space Law. It has hosted the 2017 Global Space Exploration Conference, the 13th Meeting of the International Committee on Global Navigation Satellite Systems, the United Nations/China Forum on Space Solutions: Realizing the Sustainable Development Goals, the Wenchang International Aviation and Aerospace Forum, the Zhuhai Forum, the International Summit on BDS Applications, and the Fengyun Satellite User Conference.

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China has helped developing countries train professionals. Through the Regional Centre for Space Science and Technology Education in Asia and the Pacific (China) (Affiliated to the United Nations), it has trained almost 1,000 space-industry professionals for more than 60 countries, and established the Belt and Road Aerospace Innovation Alliance and the Association of Sino-Russian Technical Universities. It has also promoted personnel exchanges in remote-sensing and navigation technology through the International Training Program and other channels.

China has promoted scientific and technological exchanges in the fields of space science, remote sensing and navigation through the China-Europe Space Science Bilateral Meeting, the China-EU-ESA Dialogue on Space Technology Cooperation, and the Dragon Programme — a joint undertaking between ESA and the Ministry of Science and Technology of China.

3. Key Areas for Future Cooperation

In the next five years China will be more open and active in broadening bilateral and multilateral cooperation mechanisms, and will engage in extensive international exchanges and cooperation in the following key areas:

(1) Global governance of outer space

Under the framework of the United Nations, China will actively participate in formulating international rules regarding outer space, and will work together with other countries to address the challenges in ensuring long-term sustainability of outer space activities.

China will actively participate in discussions on international issues and the development of relevant mechanisms, such as those in the fields of space environment governance, near-Earth objects monitoring and response, planet protection, space traffic management, and the development and utilization of space resources.

China will cooperate in space environment governance, improve the efficiency of space crisis management and comprehensive governance, conduct dialogue with Russia, the United States and other countries as well as relevant international organizations on outer space governance, and actively support the construction of APSCO's space science observatory.

(2) Manned spaceflight

China will employ its space station to conduct space-based astronomical observations, Earth science and research, and space science experiments under conditions of microgravity.

China will promote more extensive international cooperation in astronaut selection and training, joint flights and other fields.

(3) BeiDou Navigation Satellite System

China will continue to participate in the activities of the UN's International Committee on Global Navigation Satellite Systems and promote the establishment of a fair and reasonable satellite navigation order.

China will actively improve compatibility and interoperability of global satellite navigation systems such as the BeiDou Navigation Satellite System and other such systems as well as satellite-based augmentation systems.

China will prioritize cooperation and exchanges, and share with others mature solutions, on the application of the BeiDou Navigation Satellite System, thereby boosting the socio-economic development of partner countries.

(4) Deep-space exploration

China will advance cooperation on the international lunar research station project. It welcomes international partners to participate in the research and construction of the station at any stage and level of the mission.

It will expand cooperation in the fields of asteroid and interplanetary exploration.

(5) Space technology

China will support cooperation on satellite engineering and technology. It will complete the joint research and development of MisrSat-2, and launch the SVOM (Space-based multiband astronomical Variable Objects Monitor), and the China-Italy Electromagnetic Monitoring Experiment Satellite 02. It will press ahead with follow-up cooperation in the China-Brazil Earth Resources Satellites program.

China will engage in cooperation on space TT&C support. It will continue to cooperate with the European Space Agency in the field of TT&C support, and further advance the building of ground station networks.

China will support international cooperation on commercial spaceflight, including:

(a) launching services;

(b) technical cooperation on whole satellites, on subsystems, spare parts, and electronic components of satellites and launch vehicles, on ground facilities and equipment, and on other related items.

It will give priority to developing communications satellites for Pakistan and to cooperating on the construction of the Pakistan Space Center and Egypt's Space City.

(6) Space applications

China will promote global application of data from Chinese meteorological satellites, support the provision of data from the China-France Oceanography Satellite to the World Meteorological Organization, and promote global sharing and scientific application of the data obtained by Zhangheng-1, China's seismo-electromagnetic satellite.

China will press ahead with the construction of the Belt and Road Initiative Space Information Corridor, and strengthen cooperation on the application of remote-sensing, navigation, and communications satellites.

China will press ahead with the construction of the data-sharing service platform of APSCO.

China will advance the construction and application of the BRICS remote-sensing satellite constellation.

China will participate in the construction and use of the Space Climate Observatory.

(7) Space science

By means of the deep-space exploration project, and using extraterrestrial samples and exploration data, China will conduct joint research in fields such as the space environment and planetary origin and evolution. Through the United Nations scientific data obtained by the Chang'e 4 satellite will be made available to the international community.

China will boost joint R&D on space science satellites and research subjects such as dark matter particles, solar burst activities and their influence, and spatial gravitational wave.

(8) Personnel and academic exchanges

China will conduct personnel exchanges and training in the space industry.

China will hold high-level international academic exchange conferences and forums.

Conclusion

In today's world, a growing number of countries are seeing the importance of space and are investing more on their space programs. The space industry around the world has entered a new stage of rapid development and profound transformation that will have a major and far-reaching impact on human society.

At this new historical start toward a modern socialist country, China will accelerate work on its space industry. Guided by the concept of a global community of shared future, it will work actively with other countries to carry out international space exchanges and cooperation, safeguard outer space security, and strive for long-term sustainability in activities related to outer space. By doing so, China will contribute more to protecting the Earth, improving people's well-being, and serving human progress.