

China's Space Program: A 2021 Perspective

2021中国的航天

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Preamble

“To explore the vast cosmos, develop the space industry and build China into a space power is our eternal dream,” stated 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 towards 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 Towards 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-round manner:

前言

习近平总书记指出，“探索浩瀚宇宙，发展航天事业，建设航天强国，是我们不懈追求的航天梦。”中国始终把发展航天事业作为国家整体发展战略的重要组成部分，始终坚持为和平目的探索和利用外层空间。

2016年以来，中国航天进入创新发展“快车道”，空间基础设施建设稳步推进，北斗全球卫星导航系统建成开通，高分辨率对地观测系统基本建成，卫星通信广播服务能力稳步增强，探月工程“三步走”圆满收官，中国空间站建设全面开启，“天问一号”实现从地月系到行星际探测的跨越，取得了举世瞩目的辉煌成就。

未来五年，中国航天将立足新发展阶段，贯彻新发展理念，构建新发展格局，按照高质量发展要求，推动空间科学、空间技术、空间应用全面发展，开启全面建设航天强国新征程，为服务国家发展大局、在外空领域推动构建人类命运共同体、促进人类文明进步作出更大贡献。

为介绍2016年以来中国航天活动主要进展、未来五年主要任务，进一步增进国际社会对中国航天事业的了解，特发布本白皮书。

一、开启全面建设航天强国新征程

（一）发展宗旨

探索外层空间，扩展对地球和宇宙的认识；和平利用外层空间，维护外层空间安全，在外空领域推动构建人类命运共同体，造福全人类；满足经济建设、科技发展、国家安全和社会进步等方面的需求，提高全民科学文化素质，维护国家权益，增强综合国力。

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

(二) 发展愿景

全面建成航天强国，持续提升科学认知太空能力、自由进出太空能力、高效利用太空能力、有效治理太空能力，成为国家安全的维护者、科技自立自强的引领者、经济社会高质量发展的推动者、外空科学治理的倡导者和人类文明发展的开拓者，为建设社会主义现代化强国、推动人类和平与发展的崇高事业作出积极贡献。

(三) 发展原则

中国发展航天事业服从和服务于国家整体发展战略，坚持创新引领、协同高效、和平发展、合作共享的原则，推动航天高质量发展。

——创新引领。坚持创新在航天事业发展中的核心地位，建强航天领域国家战略科技力量，实施航天重大科技工程，强化原创引领的科技创新，持续优化创新生态，加快产品化进程，不断提升航天自主发展能力和安全发展能力。

——协同高效。坚持系统观念，更好发挥新型举国体制优势，引导各方力量有序参与航天发展，科学统筹部署航天活动，强化空间技术对空间科学、空间应用的推动牵引作用，培育壮大新模式新业态，提升航天发展的质量效益和整体效能。

——和平发展。始终坚持和平利用外层空间，反对外空武器化、战场化和外空军备竞赛，合理开发和利用空间资源，切实保护空间环境，维护一个和平、清洁的外层空间，使航天活动造福全人类。

——合作共享。坚持独立自主与开放合作相结合，深化高水平国际交流与合作，拓展航天技术和产品全球公共服务，积极参与解决人类面临的重大挑战，助力联合国2030年可持续发展议程目标实现，在外空领域推动构建人类命运共同体。

二、发展空间技术与系统

中国航天面向世界科技前沿和国家重大战略需求，以航天重大工程为牵引，加快关键核心技术攻关和应用，大力发展空间技术与系统，全面提升进出、探索、利用和治理空间能力，推动航天可持续发展。

(一) 航天运输系统

2016年以来，截至2021年12月，共完成207次发射任务，其中长征系列运载火箭发射共完成183次，总发射次数突破400次。长征系列运载火箭加速向无毒、无污染、模块化、智慧化方向升级换代，“长征

total launch attempts exceeded 400.

The Long March carrier rockets are being upgraded towards non-toxic 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 hyper-spectral 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

五号”“长征五号乙”运载火箭实现应用发射，“长征八号”“长征七号甲”实现首飞，运载能力持续增强。运载火箭多样化发射服务能力迈上新台阶，“长征十一号”实现海上商业化应用发射，“捷龙一号”“快舟一号甲”“双曲线一号”“谷神星一号”等商业运载火箭成功发射。可重复使用运载器飞行演示验证试验取得成功。

未来五年，中国将持续提升航天运输系统综合性能，加速实现运载火箭升级换代。推动运载火箭型谱发展，研制发射新一代载人运载火箭和大推力固体运载火箭，加快推动重型运载火箭工程研制。持续开展重复使用航天运输系统关键技术攻关和演示验证。面向航班化发射需求，发展新型火箭发动机、组合动力、上面级等技术，拓展多样化便利进出空间能力。

(二) 空间基础设施

卫星遥感系统。高分辨率对地观测系统天基部分基本建成，对地观测迈进高空间分辨率、高时间分辨率、高光谱分辨率时代。陆地观测业务服务综合能力大幅提升，成功发射“资源三号”03星、“环境减灾二号”A/B星、高分多模综合成像卫星、高光谱观测卫星以及多颗商业遥感卫星等。海洋观测实现全球海域多要素、多尺度、高分辨率连续覆盖，成功发射“海洋一号”C/D星、“海洋二号”B/C/D星。大气全球化、精细化综合观测能力实现跃升，成功发射新一代静止轨道气象卫星“风云四号”A/B星，实现全天候、精细化、连续大气立体综合探测和快速响应灾害监测，成功发射“风云三号”D/E星，形成上午、下午、晨昏星业务组网观测能力，成功发射“风云二号”H星，为“一带一路”沿线国家和地区提供卫星监测服务。遥感卫星地面系统进一步完善，基本具备卫星遥感数据全球接收、快速处理与业务化服务能力。

卫星通信广播系统。固定通信广播卫星系统建设稳步推进，覆盖区域、通信容量等性能进一步提升，成功发射“中星”6C、“中星”9B等卫星，支持广播电视业务连续稳定运行；成功发射“中星”16、“亚太”6D卫星，单星通信容量达到50Gbps，中国卫星通信进入“高通量”时代。移动通信广播卫星系统逐步完善，成功发射“天通一号”02/03星，与“天通一号”01星组网运行，具备为中国及周边、亚太部分地区手持终端用户提供语音、短消息和数据等移动通信服务能力。中继卫星系统建设迈入升级换代新