BALERION SPACE VENTURES PRESENTS:

CHINA'S RISE TO SPACE

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Executive Summary

"To explore the vast cosmos, develop the space industry and build China into a space power is our eternal dream"
"We have witnessed major successes on multiple fronts, including human spaceflight, lunar and martian exploration ... satellite navigation, quantum information, nuclear power technology..."
- President Xi Jinping

China intends to surpass the United States as the leading space power by 2049. Indeed the US Department of Defense itself warned that this would happen by 2045. The Chinese government views space operations as critical to geopolitical competition and expects space operations to become more relevant in the future. China has a vision for space backed by a comprehensive and detailed plan to build infrastructure to exploit the entire solar system by 2100. Milestones on this plan are rapidly being met and the trajectory of advancement remains impressive.

China's major recent achievements in space include:

1. A record 67 completed launches to space in 2023, 17 of which were commercial (25%). This is more launches in a year than any other country except for the United States.
2. China's latest space station had its laboratory modules added in 2022, completed its first crew rotation in 2023, and will be joined by the Xuntian telescope in 2025.
3. China launched the world's first liquid oxygen-methane rocket and has plans to test a reusable large rocket next year.
4. China demonstrated a successful sea-based launch.
5. China's secret spaceplane, Shenlong, successfully landed after 276 days in space.
6. China is the only country to have landed on the far side of the moon.
7. China is one of three countries to have landed on Mars.
8. China launched and tested the world's first quantum communications satellite.
9. China likely leads the world in tactical launch and hypersonics.

At Balerion Space Ventures, we believe that China, whether as a formidable opponent or ally, will have rapid success in space and defense technology, and that these accomplishments will drive an economic and military competitive response from the United States and allies. In both China and the United States, the private sector continues to play a larger role in successfully completing major missions. These two factors - a fast growing Chinese space program and a trend to commercial provision of space technology - will assure consistent and increasing government investment in space and defense technology by the United States. Opportunities for space technology investment abound now and will grow exponentially in the coming years in the race for what will become an economy in the trillions of dollars. Achievements in space will determine the balance of power among sovereign nations on Earth with near limited opportunities and possibilities never before seen on earth.

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I. CHINA'S VISION FOR SPACE

A comprehensive infrastructure encompassing the entire solar system by 2100

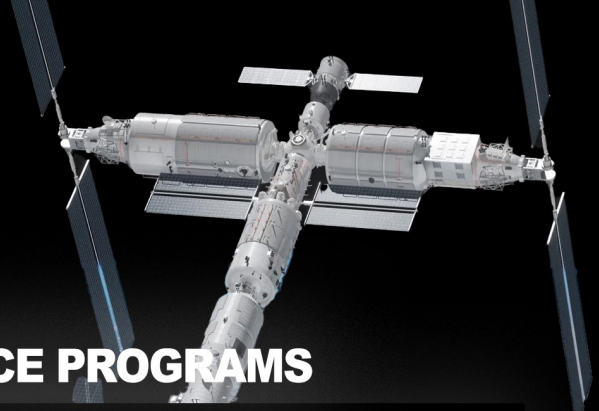
Figure 1: President Xi Jinping speaking to taikonauts aboard the Tiangong-2 space station
Source: (https://www.ft.com/content/8a6bb0c0-9a6f-46c0-8438-48984c5e32dc)

China intends to become the world's dominant power in geopolitical competition. China's view is that whichever country dominates space will dominate geopolitics. The intention is to surpass the United States as the leading space power by 2049, which is the 100th anniversary of the founding of the People's Republic of China (PRC). The Tiangong Kaiwu, translated "The Exploitation of the Works of Nature", is a detailed four-stage plan to utilize the resources of the entire solar system by the year 2100. "A 'great space age' featuring the use of space resources will … create the next miracles in human history and bring new prosperity to our civilization." President Xi Jinping is credited with facilitating a comprehensive vision for space with interests in economic and military opportunity, development of science and technology, and political prestige increasing the legitimacy, demonstrated competency, and geopolitical position of the Chinese Communist Party (CCP). The plan builds upon and echoes the country's successful global infrastructure development strategy referred to as the Belt and Road Initiative.

In addition to a record of successes in commercial launch, crewed space stations, lunar landing, Martian exploration, and satellite coverage, priorities include:

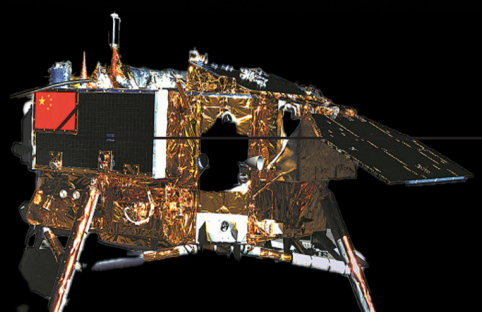
1. A global low earth orbit (LEO) 13,000 satellite network similar to SpaceX's Starlink.
2. A reusable super heavy rocket, the Long March 9, similar to SpaceX's Starship.
3. Human landing on the moon by 2030.
4. A Mars sample return mission, named Tianwen 3, by 2030.
5. Lunar development including a nuclear powered base and a research station in the lunar south pole by 2036.
6. A nuclear powered space shuttle by 2040.
7. A space-based solar power station weighing 10,000 tons and producing on the order of megawatts by 2030 and gigawatts by 2050.
8. A large and diverse enterprise of space platforms in multiple orbits with the ability to construct more platforms in space.
9. A comprehensive infrastructure and logistics system for the solar system enabling science, exploration, and resource extraction including water and mining from near earth asteroids (NEA), Mars, the asteroid belt, and the moons of Jupiter by 2100.

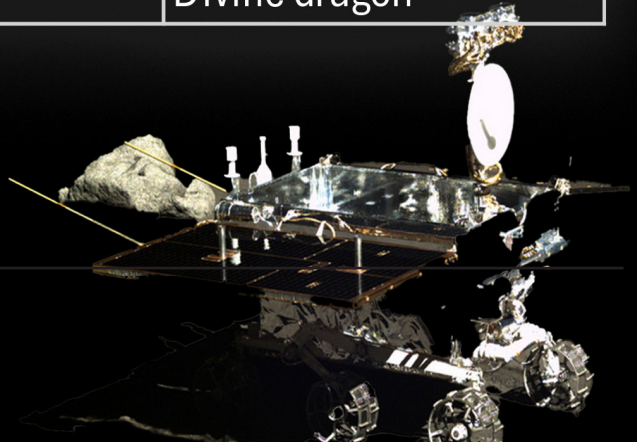
What follows is an overview of China's accomplishments in space, their current and projected capabilities, and implications for investment in space and defense technology in the United States.



CULTURAL NAMES IN SPACE PROGRAMS

Name	Technology	Translation
Long March	Rocket Family	CCP Army's 1934-35 retreat in the Chinese Civil War during which Mao's leadership was solidified
Tiangong	Space Station	Heavenly place
Shenzhou	Missions that take Taikonauts to space	Divine Vessel, also a homonym for ancient name for China (Divine Land)
Chang'e	Lunar spacecraft	Goddess of the moon
Yutu	Lunar rover	The rabbit companion of the moon goddess Chang'e
Don Dang Hong	Satellite	The east is red
Zhurong	Mars rover	God of fire
Micius	Satellite with quantum encryption	Chinese philosopher logician
Shenlong	Space plan	Divine dragon





II. CHINESE AEROSPACE SINCE 1956

With roots in the United States and Germany, China's space program had a slow start before achieving rapid success. Mishaps in the 1990s led to a disconnect between the US and Chinese space programs. Security concerns limit cooperation with and investment from the US. Vertically integrated by necessity, the Chinese space program now rivals, and in some areas superpasses, the United States program.

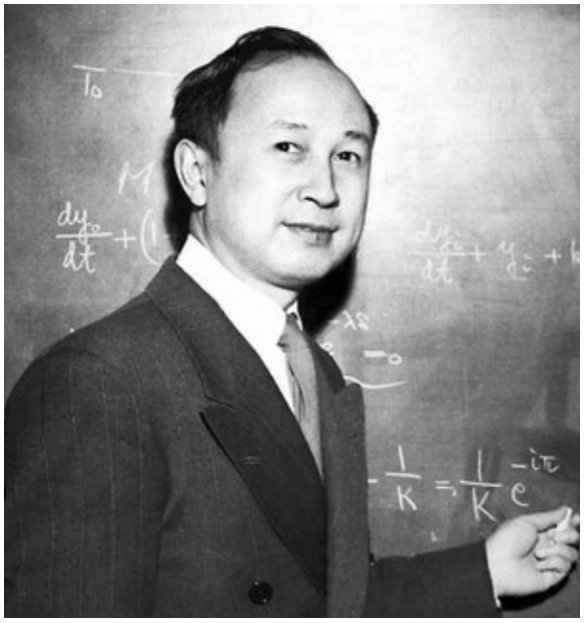


Figure 2: Qian Xuesen, who helped establish the US rocket program, is considered the father of Chinese aerospace

1956-1990 The nascent PRC space program

The People's Republic of China (PRC) was declared on October 1, 1949, following the victory of the Chinese Communist Party (CCP) in their civil war. A turbulent period of transition to heavy industries as part of a planned economy followed. Later in the following decade, the space race between the United States (US) and the Union of Soviet Socialist Republics (USSR) had begun when the Soviet Union launched the Sputnik 1 satellite to low earth orbit (LEO). One year earlier, in China, in 1956, a brilliant aerospace engineer, Qian Xuesen known as "the father of Chinese aerospace", was appointed as the director of the Fifth Academy of the Chinese Ministry of Defense, what would later become the Chinese Academy of Space Technology (CAST). Xuesen had come to the US for graduate school, finishing his doctorate at Caltech in 1939. He would go on to become a founder of the US rocket program. As a US Army Colonel in World War II he would complete post-war debriefing of captured German rocket scientists and later direct research for the US's first successful solid-fueled missile. Following the war, he left the Massachusetts Institute of Technology (MIT) to become director of the Jet Propulsion Laboratory (JPL) at Caltech in 1949 (The JPL name had been coined by Xuesen and two fellow researchers years earlier). While there, he worked on a space plane design that would become a precursor to the later Space Shuttle. The next year, in 1950, he was detained on charges of espionage and spent the next five years on house arrest. He returned to China in 1955 in exchange for American pilots imprisoned in China. Serving in China, he went on to train the first generation of PRC aerospace engineers, which ultimately led to the first Dongfeng ballistic missiles and Long March rockets. Initial progress was slow, in part due to China's political rupture with the Soviet Union in 1960 (the Sino-Soviet split) who had provided two missiles and technical support, and in part due to internal political turmoil. Nonetheless, by 1964, led by Xuesen, the Dongfeng-2 missile had a successful launch. By 1970, a later iteration of the Dongfeng missile had become the Long March 1 rocket and launched a satellite, the Don Fang Hong 1 into orbit.

Figure 3: Dongfeng-2 missile
SourceL (https://gjia.georgetown.edu/2021/12/29 the-dual-nature-of-chinas-nuclear-modernization/)

In 1975, the program had successfully launched and retrieved a recoverable satellite. In 1982, the workhorse Long March 2C rocket with a 2500 kg payload was launched. China's first geostationary orbit communications satellite was launched in 1984 on a Long March 3 rocket.

1990-2011 Chinese commercial launch success and setback

A major milestone occurred in 1990 when a **Long March 3 rocket launched a privately contracted satellite**, AsiaSat 1 by the US company Hughes Aircraft, into geosynchonous orbit. A more powerful Long March 2E rocket with payload booster-assisted to 3000 kg had a successful test launch in 1990 and raised hope for the emergence of a low-cost private launch option. Hughes again contracted, this time for the launch of two Optus satellites which were successfully launched, on second attempt, in 1992. In 1993, the China Aerospace Corporation was started and titled the China National Space Administration (CNSA). This marked the beginning of over **15 years of commercial launch success but was marred by two, politically costly, early failures**. First, in January 1995, a Hughes Apstar 2 communications satellite was launched by a Long March 2E rocket which exploded 50 seconds after liftoff killing at least 6 people. Second, in February 1996, the maiden launch of an improved Long March 3B rocket carried an American Loral contract Intelsat 708 telecommunications satellite but crashed 22 seconds after liftoff, having traveled horizontally and killing 6 people and injuring 57. Major overhauls to the space program were undertaken leading to significant improvements and, ultimately, **achieving 102 successful launches between 1996 and 2011**. Despite the subsequent success, costs had been impacted by insurance rates following the early launch failures.

Figure 4: Intelsat 708 launch crash site 1996
Source: (https://www.smithsonianmag.com/air-space-magazine/disaster-at-xichang-2873673/)

1999 ITAR keeps China from launching satellites with any US components

The Intelsat 708 and Apstar 2 failures led to an American investigation, and subsequent "Cox Report" in 1999, which concluded that the PRC obtained significant benefit from the crashes which represented a liability going forward. There was concern that the Hughes accident investigation, which was shared with China by the company, may have inadvertently given valuable technological help to the CCP that significantly improved their rockets. There was also concern, as Intelsat and Loral teams were kept from the debris site for 12 hours, that China may have captured some valuable technology. As a result, **satellite technology was placed under International Traffic in Arms Regulations (ITAR). The US Department of State has not approved a satellite export to China since 1998.**

2011 Wolf Amendment limits collaboration between the US and China in space

The aforementioned 1999 report, further concerns about leaks of technology and expertise to China's space program and a desire to nudge China to improve its human rights record led to the 2011 Wolf Amendment which has since been included on the National Aeronautics and Space Administration's (NASA) annual appropriations bill.

This amendment keeps NASA from working with the Chinese government or commercial agencies by prohibiting specified funding from being used to collaborate with China or Chinese companies unless certified by the Federal Bureau of Investigation (FBI) that there is no risk of information sharing or US involvement in the violation of human rights. In this setting, China has proceeded to develop its own space capabilities. **In spite of this limitation, NASA and the CNSA co-operated to monitor the landing of the Chang'e 4 moon landing in 2019,** with US congressional approval, and might have set a precedent for future collaboration.

2021 executive order prohibits US companies and individuals from investing in Chinese space industry

In January 2021, US Executive Order "Addressing the Threat from Securities Investments that Finance Communist Chinese Military Companies" prohibited US companies and individuals from investing in a list of companies associated with the Chinese military, which includes Chinese space corporations.

2024 and beyond

China intends to proceed with a far-side lunar sample return, a co-orbiting telescope module for the Tiangong space station, a crewed moon landing, fully operational reusable rockets, a NEA sample return, a Mars sample return, and a Jupiter and Uranus probe.

China Builds a World-Class Space Program

1999

In November 1999 the Shenzhou-1, built for human spaceflight, launched into LEO, completed 14 orbital rounds, and landed safely back on earth. With this success the Chinese Manned Spaceflight program was made public.

2003

China launched a human, Yang Liwei, into orbit in the Shenzou-5 becoming the third country, behind Russia and the US, to do so.

2000 - 2020

From 2000 to 2020, the BeiDou Navigation Satellite System was deployed to provide geolocation on or near earth. It has 35 operational satellites in medium earth orbit (MEO) and geostationary orbit (GEO) and now provide global coverage. The European Gallileo Position System, the Pakistani Armed Forces, the Saudi Ministry of Defense, and Russia have all entered into cooperation with this project. It is illegal to use BeiDou in Taiwain.

2007

In January 2007, China completed an anti-satellite missile (ASAT) test successfully destroying their own old non-operational weather satellite in LEO. Although it caused political controversy, it was the third country to complete an ASAT test behind the US and Russia. India later completed one in 2019.

2007

Also in 2007, the Chang'e 1 orbited the moon and later executed a hard landing on the lunar surface.

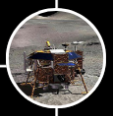
2012

In 2012, the Chang'e 2 probe completed a close fly-by of a near-earth asteroid, 4179 Toutatis, after it had orbited the moon.

2013 - 2023

From 2013 to 2023, the China High-Resolution Earth Observation System (CHEOS) was deployed. This is a 32 satellite network combined with airships, unmanned aerial vehicles, and ground stations to monitor agriculture, disaster, atmosphere, environment, and resources. It was expanded over those years by joining with Russia and later the rest of the BRICS to share sensing data.

2013



In December 2013, the Chang'e 3 successfully had a soft-landing on the moon accompanied by the Yutu rover that deployed the day after landing.

2014

In 2014, China opened and encouraged investment into private commercial space firms leading to a boom in new companies. Since then over $6.5B USD has been invested and there are now over 100 private space companies in China.

2016 & 2017

Tiangong-2, China's first operational space station was launched in September 2016 and was manned with taikonauts a month later. In April 2017, the first resupply mission was successfully executed.

2016

In 2016, China launched the world's first quantum communication satellite, Micius.

2019

In 2019, the Chang'e 4 made the first landing on the far side of the moon. The communications issue that had previously precluded a mission like this was solved by having a communication relay satellite placed at an Earth-Moon Lagrange point the year prior. The Yutu-2 rover was deployed to the lunar crater as part of the mission. A notable event was the biosphere on the lander demonstrated the first other-world plant growth including sprouting and growing of cotton and potato.

2019

Also in 2019, China made its first sea launch using a Long March 11 rocket. This made China the third country to successfully launch from sea.

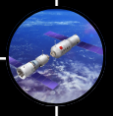
2020

The Chang'e 5 in 2020 was a successful lunar sample return mission accomplished via automated rendezvous and docking in lunar orbit to facilitate sample return to earth.

2020

Launched in 2020, the Tianwen-1 mission to Mars in 2021 completed orbit, landing, and Zhurong rover deployment all in the first attempt at a Mars mission.

2021



In 2021, the Tiangong space station, successor to the Tiangong-2, construction began with its first module's launch consisting of living quarters and a docking station. Crew and two more laboratory modules were launched in 2022. Notably, in addition to chemical thrusters to maintain orbital position, the station runs four Hall-effect thrusters, a first for a spacecraft that will have humans on board.

MILESTONES IN THREE MAJOR HUMAN SPACEFLIGHT PROGRAMS

Milestones	US	Russia	China
Satellite	2/1/1958 Explorer 1 / Juno 1 rocket	10/4/1957 Sputnik 1 / R-7 rocket	4/24/1970 Dong Fang Hong 1 / Long March 1 rocket
Human to space	5/5/1961 Freedom 7 (Alan Shepard) / Redstone rocket	4/12/1961 Vostok 1 (Yuri Gagarin) / Vostok rocket	10/15/2003 Shenzhou 5 (Yang Liwei) / Long March 2F rocket
Lunar (soft) landing	5/30/1966 Surveyor 1 / Atlas rocket	2/3/1966 Luna 9 / Molniya rocket	12/1/2013 Chang'e 3 + Yutu rover / Long March 3B rocket
Lunar (far side) landing	-	-	1/3/2019 Chang'e 4 + Yutu rover
Lunar orbit	8/10/1966 Lunar 1 / Atlas rocket	3/31/1966 Luna 10 / Molniya rocket	10/24/2007 Chang'e 1 / Long March 3A rocket
Human on moon	7/20/1969 Apollo 11 (Neil Armstrong, Buzz Aldrin) / Saturn V rocket	-	-
Manned space station	5/14/1973 Skylab	4/19/1971 Salyut 1	9/29/2011 Tiangong 1
Mars orbit	11/13/1971 Mariner 9 / Atlas rocket	11/27/1971 Mars 2 / Proton K rocket	2/10/2021 Tianwen-1 / Long March 5 rocket
Mars landing	7/20/1976 Viking 1 lander	12/2/1971 Mars 3 lander	5/14/2021 Tianwen-1 lander
Mars rover	7/4/1997 Sojourner rover	-	5/22/2021 Zhurong rover
Commercial launch	3/29/1989 Starfire (Space Services Inc)	-	7/25/2019 Hyperbola-1 (i-Space)
Manned reusable spacecraft	4/12/1981 Columbia space shuttle	-	-
Reusable rocket	12/22/2015 Falcon 9 booster stage (SpaceX)	-	-

III. CURRENT AND PROJECTED CHINESE SPACE CAPABILITIES

Organized under two major government corporations, China's space ecosystem includes five operational spaceports; several public and private launch companies; a large fleet of small, medium, and heavy rocket vehicles with the full spectrum solid and liquid fuel options; super heavy rockets in development; thousands of satellites in various networks in progress; advanced manufacturing for space systems, an operational space station; an experimental reusable space plane; and a fleet of hypersonic weapons. Their system is highly integrated with the military. While China is a signatory of the 1967 UN Outer Space Treaty, it is not a participant in the US Artemis Accords.

The **China National Space Administration (CNSA)** assumes the role of setting and executing national space policy, managing the Chinese space industry, and representing the government in space related international agreements. Two major state-owned corporations operate the space industry:

- **China Aerospace Science and Technology Corporation (CASC)** is the chief contractor with subsidiaries that design and build spacecraft, launch vehicles, missile systems, and launch systems.
- **China Aerospace Science and Industry Corporation (CASIC)** itself designs and builds spacecraft, launch vehicles, missile systems, and launch systems.

There are five operating spaceports in China, which include facilities for commercial launch and launch at sea. There are eleven launch service providers, and there are a large number of rockets, spacecraft, and supporting technology.

Figure 5: The five major spaceports in China
Source: (https://www.thespacetechie.com/china-national-space-administration/)

China operates five main launch sites, all of which are controlled by the People's Liberation Army (PLA): Jiuquan, Taiyuan, Xichang, Wenchang, and Hainyang.

Jiuquan Spaceport	Crewed missions/LEO/Military
Taiyuan Spaceport	LEO/SSO
Haiyang Spaceport	Sea launch
Xichang Spaceport	GEO
Wenchang Spaceport	Heavy lift + Hainan Commercial Launch Site

Wenchang spaceport was completed in 2014 on Hainan island. A second Hainan Commercial Launch site was more recently built adjacent to Wenchang. The Hainan island, south of mainland China, is desirable for its location closer to the equator and therefore chosen for the heavier launches. Wenchang has a surrounding successful and growing space tourism industry including a Hilton Hotel. Where the Wenchang spaceport is state-run, the adjacent Hainan site was funded by major investors and partners with a vision for the launch center to support the nearby rocket and satellite manufacturing companies. For example, the upcoming SatNet/Guowang satellite network, seen as a Starlink competitor, will be launched from Hainan. There is also a vision that in the future, the regional integration of manufacturing and launch efficiencies and standardization may make the region viable and competitive for foreign customers.

Hainyang spaceport, developed by CASC, is off the east coast of China and has a mobile rocket launch barge for sea launch. The floating spaceport has supported both state and commercial launches of smaller solid fueled rocket launches and has expanded to support liquid propellant options. Most recently though, the Gravity-1 rocket with an impressive medium payload capacity of 6,500 kg successfully completed a launch of three satellites from sea. Similar to the Wenchang region, a surrounding rocket, satellite, and spacecraft manufacturing industry is growing in conjunction. Launch from sea has the advantage of positioning closer to the equator to reduce fuel use, having larger safety margin from debris and failed launches away from populated areas, and having a related lack of sound pollution to populated areas.

Jiuquan spaceport in the Gobi Desert was built in 1958 and later developed by CASIC who is also the maker of the Kuaizhou rocket series. Landspace more recently built commercial support facilities there. Jiuquan is the launch site for the human spaceflight program and regularly supports satellite launches via state and commercial launch providers.

Taiyuan spaceport was built in 1968. The Haiyang spaceport falls under the jurisdiction of Taiyuan.

Xichang spaceport came into service in 1984. It is notable for being the site of the 1996 Intelsat 708 crash, the 2007 ASAT test, and the site of the Sino-European space cooperation.

Launch Service providers

Where CASC and CASIC had historically been building and operating all aspects of the space industry, including launch, an infusion of private capital has expanded the involved corporations over the past ten years. There are now at least eleven major launch providers, eight to nine of which are commercial.

Launch Service Providers

China Academy of Launch Vehicle Technology	-State owned
	-Manufacturer of the Long March rockets
	-Two new reusable rockets to come in 2025 and 2026
ExPace	-State owned subsidiary of CASIC
	-Manufacturer of the Kuaizhou small satellite launch vehicles with solid rocket engines
	-Successful test launch, hover, and land of reusable rocket in January 2024
	-Cheapest Chinese launch provider at $10,000/kg
CAS Space	-Commercial
	-Partially owned by the China Academy of Sciences with aim to commercialize work from there
	-Has launch pad and facilities at the Jiuquan spaceport
	-Manufacturer of the Kinetica rockets
	-Space tourism vehicle planned for 2025
Deep Blue Aerospace	-Developing 4,500 (LEO) payload reusable rocket, the Nebula-1
	-Two rounds of funding for $31M and ?
	-Completed a successful 1 km vertical take off and landing test May 2022
Galactic Energy	-Manufacturer of the Ceres-1 rockets
	-Developing the Pallas 1 and 2 rockets
	-Raised $200M in January 2022 to develop reusable rockets
	-Long term vision to mine asteroids
i-Space	-First private space company to reach orbit
	-Manufacturer of the Hyperbola-1 rocket
Landspace	-Builder of the Zhuque-2 rocket which is the first methalox rocket in the world to reach orbit then also became the first one to put payloads into orbit
Linkspace	-Developing reusable rockets
	-Developing small rockets to launch microsats and nanosats
OneSpace	-Developing small suborbital and orbital rockets
OrienSpace	-Four rounds of fundraising totaling $150M
	-Builds Gravity Series launch vehicles and Force Series rocket engines
	-Gravity 1 is China's most powerful commercial rocket
	-Gravity 1 is the world's largest solid fueled rocket
Space Pioneer	-Manufacturer of Tianlong rockets and engines

State Owned Commercial Mixed

ROCKETS

Government and commercial manufacturers supply small, medium, and heavy launch rocket options with super-heavy rockets in development. There are solid and liquid propellant applications including kerosene and methalox. Landspace's Zhuque-2 medium payload is the first, and so far only, methane fueled rocket to reach orbit.
*in development

Small-lift (up to 2,000 kg)

Long March 11	700 kg (LEO)
Long March 6	1500 kg (LEO)
Jielong-3	1,500 kg (LEO/SSO)
Kinetica-1	2,000 (LEO)
	1,500 (SSO)
Kuaizhou 1	430 kg (SSO)
Kuaizhou 1A	300 kg (LEO)
	200-250 kg (SSO)
Kuaizhou 11	1500 kg (LEO)
	1000 kg (SSO)
Ceres-1	400 kg (LEO)
	300 kg (SSO)
Hyperbola-1	300 kg (LEO)
Tianlong-2	1,814 kg (LEO)
	1,361 (SSO)

State Owned

Mixed

Commercial

Medium-lift (2,000-20,000 kg)

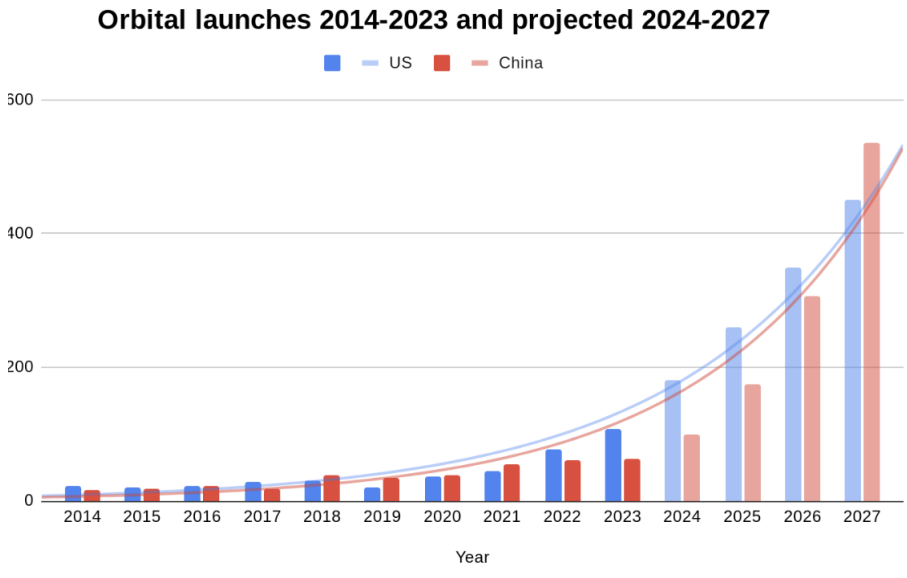
Long March 2D	3,500 kg (LEO)
	4,000 kg (LEO)
Long March 2C	1,250 kg (GEO)
Long March 4B	4,200 kg (LEO)
	4,200 kg (LEO)
Long March 4C	1,500 (GEO)
	4,500 kg (LEO)
*Long March 6C**	*1,400 kg (GEO)*
	6,000 kg (LEO)
Long March 3A	2,600 kg (GEO)
	8,100 kg (LEO)
Long March 8	2,800 kg (GEO)
Long March 2F/G	8,800 kg (LEO)
Long March 2F/T	8,800 kg (LEO)
	9,100 kg (LEO)
Long March 3 C/E	3,900 (GEO)
	11,500 kg (LEO)
Long March 3 B/E	5,500 kg (GEO)
Long March 7	14,000 kg (LEO)
	5,000 kg (LEO)
*Pallas-1**	*3,000 kg (SSO)*
	6,000 kg (LEO)
Zhuque-2	4,000 kg (SSO)
	6,500 kg (LEO)
Gravity-1	4,500 kg (SSO)

Heavy-lift (>20,000 kg)

Long March 5	25,000 kg (LEO)
	14,400 kg (GEO)
Long March 5B	25,000 kg (LEO)
*Long March 10**	*70,000 kg (LEO)*
	32,000 kg (GEO)
*Long March 9**	*150,000 kg (LEO)*
*Kuaizhou 21**	*20,000 kg (LEO)*
*Kuaizhou 31**	*70,000 kg (LEO)*

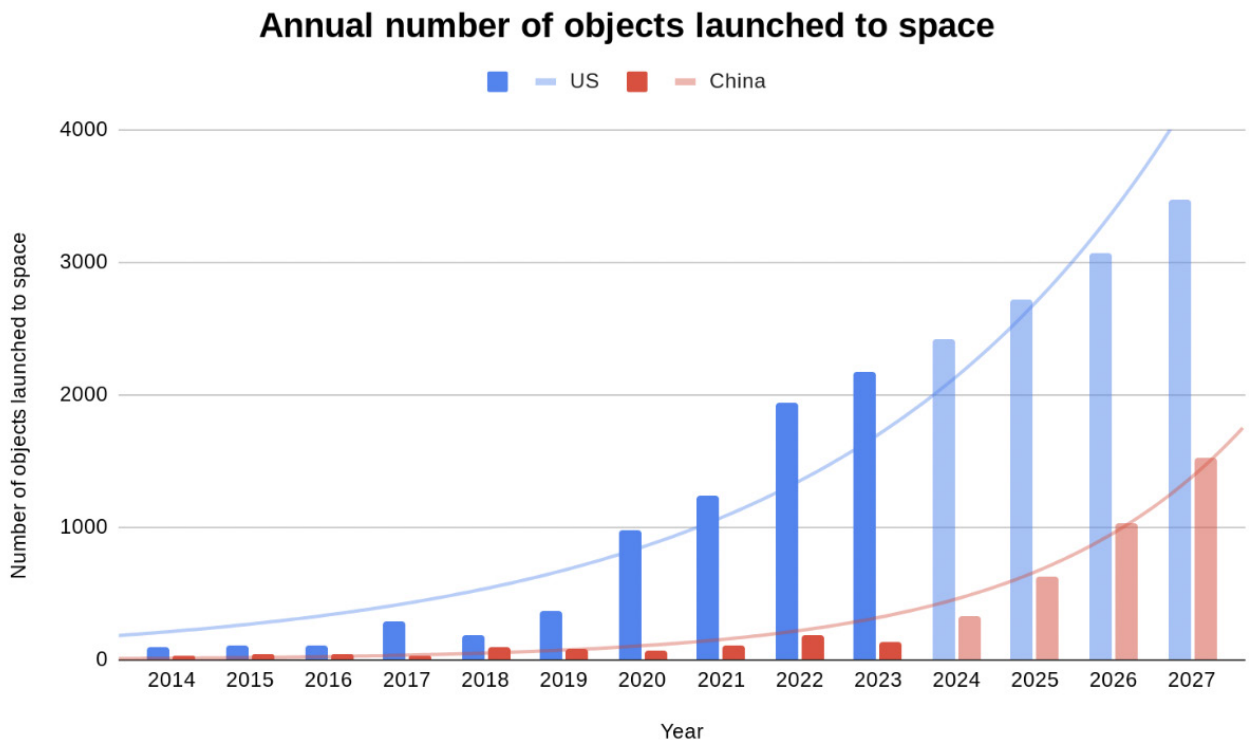
Launch Cadence

The annual pace of launch in China is accelerating. **2023 saw a record 67 launches from China. That year the US had 108 launches, 98 of which were performed by SpaceX.** China plans 100 launches for 2024, a 50% increase from the prior year.



SATELLITES

Satellites, broadly, can be deployed to facilitate communication and for observation. China now has over 600 operational satellites in space.



Tianlian Satellite System

Tianlian is a satellite communication system developed by CAST and used for tracking spacecraft. It has supported human space flight missions and the space station. The satellites are in geostationary orbit providing stable positions for more continuous contact with ground stations. The system is made up of five first generation and three second generation satellites launched between 2008 and 2022.

BeiDou Navigation Satellite System (BDS)

This is a radio navigation system similar to the US's global positioning system (GPS) that provides Positioning, Navigation, and Timing (PNT) with global coverage. It has forty-five operating satellites in multiple types of orbit and an associated ground station network. Similar to GPS, the Russian GLONASS, and European Galileo system, it has separate military (higher accuracy) and civilian signals. PNT services, in addition to obvious military uses, are economically valuable for mobile wireless applications. President Xi Jinping declared BDS "one of the most important achievements China has made in … 40 years." A major part of that sentiment derives from the fact that China no longer has to rely on foreign (i.e. US) PNT. Another major part comes from the soft power BDS has enabled as **China has extended this critical public good to developing nations within the BRI. This gives China diplomatic leverage and outsized power over these economies to the extent they rely on BDS for services. The newer BDS system is both more accurate and more widely available than GPS.**

China High-resolution Earth Observation System (CHEOS)

The Gaofen, translated "high resolution", program is made up of 32 satellites. Three satellites are in GEO and the remaining twenty-nine are in LEO.

Hard X-ray Modulation Telescope

The Hard X-ray Modulation Telescope, called Insight, was launched in 2017 and provides a tool for astronomy research.

Quantum Experiments at Space Scale (QUESS)

The **world's first quantum satellite, Micius,** was launched by the Chinese in 2016.This satellite uses Quantum Key Distribution (QKD), which creates two entangled photons and then transmits their quantum states to two different ground stations. In 2017, the satellite facilitated a long-distance video call between CAS and the Austrian Academy of Sciences using a shared quantum key. Quantum communications are thought to be unhackable due to the observer effect; if one were to hack into the signal they would be detected because their observation would change the state of the photon in question.

Geely Future Mobility Constellation

Geespace, a subsidiary of the Chinese car company Geely, has planned a 168 satellite network for precise positioning use. Twenty satellites have been launched so far between 2022 and 2024. **Geespace has established a mass production system for communication satellites for automotive use.**

Guowang (SatNet)

China intends to launch a mega-constellation of 13,000 LEO satellites to provide global broadband coverage similar to SpaceX's Starlink. The G60 Starlink is a planned 12,000 satellite project. Manufacturing by the state owned Genesat was started and the first satellite completed production at the end of 2023. 108 satellites are planned for launch in 2024 with the ultimate aim to provide broadband coverage globally. The Shanghai government has reportedly backed a project for another over 1000 satellites to add to the network.

GROUND SUPPORT STATIONS

China operates an extensive network of ground support stations nationally and throughout the world to support satellite and space operations known as telemetry, tracking, and command (TT&C). This network includes facilities in Antarctica, throughout latin america including Bolivia, Venezuela, Peru, and Argentina, and arctic facilities in Sweden, Iceland, Norway, Finland, and Greenland. A Chinese state firm has built similar ground stations in Laos, Pakistan, Nigeria, Belarus and there are stations in Namibia and Kenya associated with the PLA.

The **Chinese Deep Space Network (CDSN) is a network of facilities with large antennas and radio telescopes throughout mainland China, and one in Argentina,** used for observation and communication to support astronomy and space missions. Included in this network is the Five-hundred-meter Aperture Spherical Telescope (FAST). FAST was built in 2016, is the largest radio telescope in the world, and is expected to have an additional role in supporting future Mars missions.

The China FAST is the largest radio telescope in the world

(undark.org/2021/04/13/china-fast-telescope-open-for-business/)

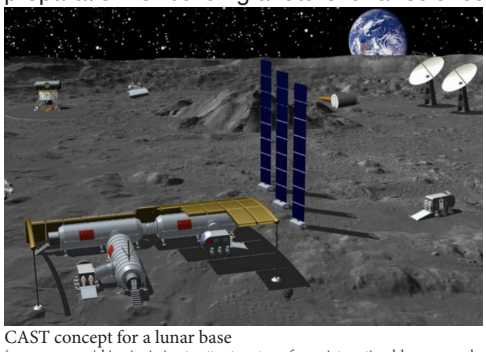
SPACE STATION

The first module of the Tiangong space station, which includes the living quarters called Tainhe, was launched in 2021. Two additional science laboratory modules, the Mengtian and Wentian, were added during launches in 2022. The Xuntian space telescope is planned to join the space station in orbit in 2025 and will be set up to use the space station for refueling. It had been preceded by the uncrewed Tiangong-1 launched in 2011 and then the crewed prototype Tiangong-2 launched in 2016. The space station serves as a scientific research platform and for technological development of extended human operations in space. Power is provided by solar. It maintains position via chemical thrusters and, in addition, has four hall-effect thrusters. It has five robotic arms to support operations such as cargo transfer. Part of China's motivation to build Tiangong was its exclusion from participation in the International Space Station (ISS) which is planned for decommission and replacement in 2030. **China has stated its goal to have foreign astronauts operating aboard Tiangong and the station has already hosted scientific experiments for Italy, Switzerland, Poland, and Germany.**

The Tiangong space station
(www.space.com/tiangong-space-station)

LUNAR MISSIONS

The Chinese Lunar Exploration Program (CLEP) began with two lunar orbit missions in 2007 and 2010. The 2010 mission also included a stop at an Earth-Sun Lagrange point to test the TT&C network and then a fly-by of the 4179 Toutatis NEA. In 2013, a successful soft landing was completed and the Yutu rover completed exploration of an approximately 1.2 square mile area. **In 2019, China completed the first landing on the far side of the moon and deployed the Yutu-2 rover to explore the large impact crater South Pole-Aitken Basin. In 2020, China completed its first successful lunar sample return mission bringing about 1.7 kilograms of lunar soil to earth. Three more south pole exploration and sample return missions are planned for between 2024 and 2028.** The 2028 mission is to include a test of 3D manufacturing in preparation for building a future lunar science base.



CAST concept for a lunar base
(spacenews.com/china-is-aiming-to-attract-partners-for-an-international-lunar-research-station/)

It began with a Memorandum-of-Understanding (MOU) between China and Russia in 2021 and expanded to include Venezuela, South Africa, Azerbaijan, Pakistan, Belarus, Egypt, the United Arab Emirates (UAE), and Pakistan. The planning received support from European experts and the United Nations (UN). China completed a MOU with the aerospace start-up nanoSPACE in Switzerland and a Letter of Intent (LOI) with the International Lunar Observatory Association in Hawaii. China has also held talks with The Thales group in France. The plan outlines construction of a transportation center and facilities between 2028 and 2035 and entry into operation in 2036.

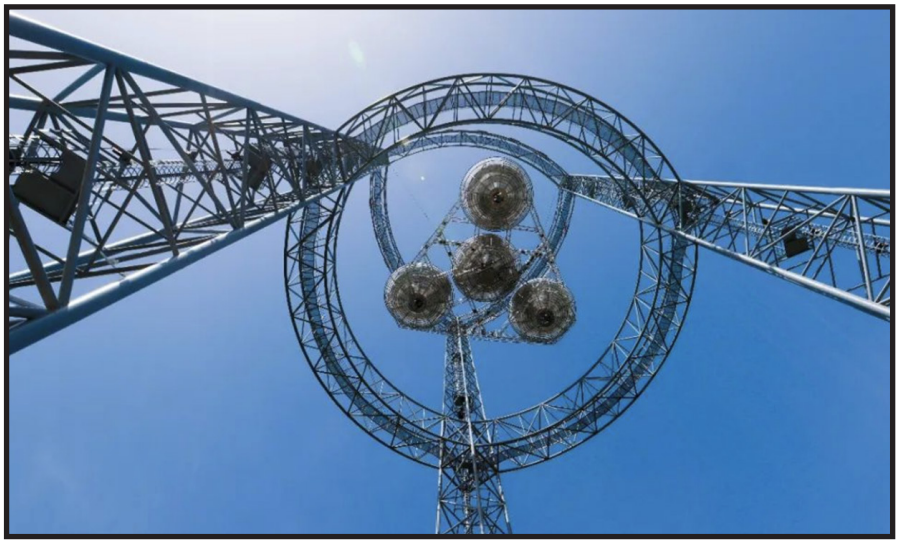
REUSABLE SPACECRAFT

China's secret spaceplane is built to launch in a rocket and land on a runway similar to the US's old space shuttles. The mission is thought to be a response to the Boeing X37-B spaceplane. Some reports have suggested that the Chinese version will be able to support a crew of six. Three successful launch missions have been completed so far in the program. **The Shenlong robotic spaceplane, as part of this program, launched in 2023, spent 276 days in orbit, successfully landed, and was again launched.** Each of the three missions were notable for the release of several small unknown objects into space.

(meta-defense.fr/en/2023/09/28/chinese_shenlong_asat_space_plane/#google_vignette)

SPACE-BASED SOLAR POWER

China is a leader in efforts to develop a space-based solar power station. Collecting solar energy via panels in space does not have the problem of intermittency that occurs on earth. The project aims to generate 1M watts, or 1 gigawatt, of power to transmit to earth via microwave to a 1 km diameter receiver dish on earth. New advances in panels, including the concept of biomimicry of butterflies to create v-shaped concentrators within photovoltaic cells, have increased the efficiency of solar panels. When combined with the advantages of being in space, these gains provide an estimated increase in efficiency of up to 40 times. In 2023, Caltech demonstrated a successful beam of power to Earth suggesting the theoretical technology could become reality. **China aims to have this project started in 2025.**



China's ground receiver for a planned space-based solar power station
(https://www.globaltimes.cn/page/202304/1289677.shtml)

HYPERSONICS

Hypersonic technology (enabling travel at greater than 5 times the speed of sound or mach 5) is currently employed for missiles but has applications to both high speed travel on earth and in space. The high speed of hypersonic missiles makes them difficult to detect and counter.

China leads the world with operational and test hypersonic missiles. They operate two test sites and have wind tunnels capable of testing speeds up to mach 12.
-DF-17 is a medium-range ballistic missile with a range of 1,600 km
-DF-41 is an intercontinental ballistic missile which carries a hypersonic glide vehicle that is capable of circumnavigating the globe
-DF-ZF is a hypersonic glide vehicle with a range of 2,000 km
-Starry-sky 2 is a nuclear-capable prototype

Russia also has a hypersonic missile arsenal.
-Kinzhal missile can achieve up to mach 10 and has a range of 2,000 km
-Avangard hypersonic glider can travel over mach 20 and has a range of over 10,000 km
-Zircon missile is ship-launched and has a top speed of mach 8 and a range of 1,000 km

The United States has invested $12 billion into the development of hypersonic missiles but does not yet have an operational unit.

Donfeng-41 ICBM
(https://tiananmenstremendousachievements.wordpress.com/2013/10/08/china-df-41-icbm-with-range-of-14000-km-able-to-break-through-us-anti-missile-network/)

POLITICAL CONSIDERATIONS

Military-Civil Fusion
Military-Civil Fusion is a long developing plan that reached maturity in 2021 with a five year plan aiming to make the PLA a world class military by 2049. The plan aims to leverage private sector talent from universities and defense companies by easing administrative burden and **promoting technology transfer and dual-use**. With the expansion of private firms into the space industry since 2014, this initiative can be used to build China's military space power.

China continued a multiyear military reform with an aim to have specialized services that can integrate seamlessly under one command similar to the US model. China continues to operate the PLA Ground Force, PLA Air Force, PLA Navy, and PLA Rocket Force. This year, The PLA Strategic Support Force (PLASSF), was replaced by four new arms: the Aerospace Force, the Cyberspace Force, the Information Support Force, and the Joint Logistics Support Force. The expertise of these new forces will allow for further development into AI and space.

International Governance in Space
Several relevant agreements apply to international operations in space. In practice, it is suspected that entities that arrive first to celestial bodies and areas will largely determine how they are used and exploited.

The 1967 UN Outer Space Treaty is signed by 114 countries including China. This treaty prohibits the use of nuclear weapons in space, prohibits establishing military bases (but not all military activities), states that no nation may make claim over a space body, and states that space should be open to all for free exploration.

The US Artemis Accords are a non-binding international cooperation to develop the moon and exploit its resources. It plans to launch the Gateway space station into cislunar orbit in 2025. Participants include the US, Japan, Europe, and Dubai. Russia and China are not signatories and, as outlined above, have established their own international cooperation for moon development.

Global cooperation

China's BRI has built impressive infrastructure, and associated goodwill, throughout the global south. More recently, China has been working on outreach to gulf states. The space program initiatives, the so-called **"Space Silk Road"**, have aligned with the BRI to create synergies.

IV. IMPLICATIONS FOR INVESTMENT

Bill Nelson, the administrator of NASA, said in an interview that he wants to make sure that "we get there first." China's aggressive push to occupy and exploit the solar system will drive US and international cooperation and competition. Comparing capabilities between the US and China can identify gaps and indicate areas worthy of investment.

CAPABILITIES: US vs CHINA

Capability	US	China
Government space spending	$73.2B USD in 2023	$14B USD in 2023
Spaceports	14	5
	+2 SpaceX	
	+1 Blue Origin	
Launch	48 to date in 2024	19 to date in 2024
	180 annual projected	*100 annual projected*
Super heavy launch	2	0
	Falcon Heavy	*In development:*
	Space Launch System	*Long March 9*
	In development:	*Long March 10*
	Starship	
Tactical launch	2 vehicles	2 vehicles
	1 launch demonstration	30 successful launches
	Pegasus (aircraft launched)	Kuaizhou-1A (truck launched)
	Minotaur (fixed launch)	Long March 1 (truck launched)
Space station	International Space Station with 16 modules to retire 2030	Tiangong Space Station with 3 modules completed 2022
Satellite navigation	GPS	BeiDou
	Accuracy to 3 meters	Accuracy to 1 meter
	31 satellites	56 satellites
	16 ground monitor stations	120 ground monitor stations
Moon orbit	Artemis I in 2022	Chang'e 1 in 2007
Moon rover landing	*VIPER planned for 2024*	Chang'e 3 in 2013
Moon human landing	*Artemis 3 planned for 2026*	*Planned to occur by 2030*
Moon sample return	*Artemis 3 planned for 2026*	Chang'e 5 in 2020
Mars orbit	Mars 2020 arrived in 2021	
	Psyche is enroute to pass in 2026	Tianwen-1 in 2021
Mars rover landing	Ingenuity landed in 2021	Zhurong in 2021
Mars sample return	*NASA-ESA planned for 2030*	*Tianwen-3 planned for 2030*
Hypersonics	*AGM-183A protoype*	DF-71
		DF-41
		DF-ZF
		Starry-sky 2 prototype
Quantum communication	*In development by US DOE and partners*	Micius satellite
Reusable spacecraft	X-37 first orbit in 2010	Shenlong first orbit in 2023
Space large scale solar	*In development*	*In development*
Space nuclear power	*In development*	*In development*

The US has spent billions of dollars to enlist private contractors in the mission to space. SpaceX has led in the $10 billion dollar launch market in addition to smaller players such as New Zealand based Rocket Lab. The satellite market is estimated at $192 billion and is growing fast. As the cost of launch decreases, business activity is expected to boom in LEO and will include areas like pharmaceutical development and manufacturing. Moon development will come next. SpaceX and Blue Origin have contracts to build lunar landers. China's success and speed into these areas will drive US focus and investment in this area so that territory isn't lost. Defense spending for space will go up so that free commerce can be protected in what is estimated to become an economy in the multiple trillions of dollars.

THANK YOU FOR READING.

Thank you for reading, and please do not hesitate to reach out to any of us with questions or for more information on Balerion Space Ventures.

We hope to hear from you soon!

- The Balerion Space Team