

Chapter 2

China's Space Programme: An Overview

This chapter provides an introductory overview of China's fast developing and increasingly complex space programme. The analysis is performed according to a categorisation created by Jim Dator,¹ who developed a framework to understand the process of technology advancement. In his view, all technological areas of development—including space programmes—can be understood as a product of three components: *hardware*, *software*, and *orgware*.

The term *hardware* in this categorisation refers to the material resources and technological capabilities of a space programme. It basically makes up the national capacities in terms of space systems (e.g. launchers, satellites, and ground facilities) and budgetary expenditures. *Orgware*, on the other hand, comprises the organisational structures set up to develop and run the hardware. The *software* of the space programme denotes the norms and rules applied to use the technological capabilities for specific purposes. These are captured in the national space policies and strategies.

In line with this taxonomy, particular attention will be paid to the organisational set-up of China's space programme, to the budgetary allocation, and to the space policies and long-term strategies adopted by Beijing. Specific consideration of China's technological capabilities will be provided in Chap. 4.

¹ Dator, Jim (1983). "Loose Connections: A Vision of Transformational Society". In: Masini, Eleonora (ed). *Visions of Desirable Societies*. Pergamon Press, Oxford. Dator's categorization has been successfully adopted and applied to the analysis of space programmes also by space policy analyst Stacey Solomone. See Solomone, Stacey (2013). *China's Strategy in Space*. Springer, New York: pp. 17–22.

2.1 Organisation of Space Activities in China

China's space programme is one of the most complicated and non-transparent in the world, and understanding its organisational and bureaucratic structures can involve significant difficulties.

These difficulties are not just a result of the high level of secrecy surrounding the programme; rather, they are determined by the combination of secrecy with other four main features, which are (a) the existence of a "Byzantine maze" of bureaucratic structures that involve a myriad of organisations, as well as countless organisations within organisations²; (b) the general complexity of the inner workings of China's power structures and hierarchies; (c) the multiple restructurings, renaming, and relocation of bureaucratic offices and institutes that have occurred through the past 50 years in the Chinese space organisation; and (d) the continuous expansion of space governance in terms of the creation of new administrative entities designed to respond to the needs of new programmes and missions.

The combination of these multiple factors not only confuses any attempt to correctly pair the various institutions, and eventually to peer into the inner workings of the Chinese system, but also raises many fears and fuels speculation. It has even been noted that often "the renaming, relocation, and lack of transparency within organisations has left employees themselves unaware" of their office's position within the overall organisational structure.³

The following section can thus only be an attempt to assess the functions and responsibilities of the most important, large, and central organisations currently involved in the governance of China's space programme.

2.1.1 A Leading Small Group on Space?

In order to reach behind the public facade of the governance of China's space programme, an insight into the structures of power and working relationships of the leadership system is provided first of all.

The first point to note is that the governance regime of the People's Republic of China (PRC) consists of three major vertical systems (*xitong*): the Chinese Communist Party (CCP), the government, and the military.⁴ The three systems operate

² Johnson-Freese, Joan (1998). *The Chinese Space Program. A Mystery Within a Maze*. Krieger Publishing Company, Malabar, FL.

³ Cheng, Dean, and Kerry Murray (2001). "Orbital Dragons: Implications of Chinese Access to Dual-Purpose Space Technologies". In: Williamson, Ray A. *Dual-Purposes Technologies: Opportunities and Challenges for US Policymaking*. Space Policy Institute. Washington DC: p.72.

⁴ Ning, Lu (2001). "The Central Leadership, Supraministry Coordinating Bodies, State Council Ministries, and Party Departments". In: Lampton, David M. (ed). *The Making of Chinese Foreign and Security Policy in the Era of Reform*. Stanford University Press, Stanford: pp. 45–49.

in a symbiotic relationship, but the role and power of the CCP—and of its Central Committee in particular—are ultimately the most prominent, and its overwhelming presence continues to overshadow the entire system. For this reason, China's leadership system has been correctly described as centred on a party-based, oligarchic, consensus-driven structure that reflects a balance among the institutional interests of its three organisational pillars.⁵

In order to build consensus on issues that cut across the government, party, and military systems and to develop rational, coherent, and balanced decision-making, high-level coordinating and consulting bodies have regularly been set up. These bodies, usually labelled Leading Small Group (LSG, *lingdao xiaozu* in Chinese), provide a mechanism for top decision-makers to exchange views on sensitive issues, build consensus, and create a framework for the general direction in which the subordinate bureaucracies should move. As noted by the US scholar Alice Miller, because these groups deal with sensitive leadership processes, they are never incorporated into publicly available charts or explanations of party/government/military institutions, but their existence has to be nonetheless acknowledged and their role ultimately considered crucial in any coherent policymaking elaboration on sensitive issues.⁶

LSGs do not generally formulate concrete policies, but create—through the provision of recommendations and guiding principles—the framework for their development. As noted by several scholars, these recommendations are likely to exert considerable influence on the policymaking process because they are an expression of the consensus reached by the leading members of the relevant government, party, and military agencies. In some cases, the Chinese leadership will adopt an LSG's recommendations with little or no modification.

An important feature of these high-level coordinating bodies is that they can be formed not only to build consensus on issues that cut across the government, party, and military systems but also on sensitive issues involving different interests within one of these three systems. In short, the State Council, the Central Committee of the CCP, and the People's Liberation Army (PLA)—respectively, the highest ranking organs of the government, the party, and the military—often create their own leading groups to coordinate policies.

LSGs are formed in regard to a broad range of issues; examples include foreign affairs, finance and economic affairs, national energy resources, environmental protection, and agricultural affairs. Sometimes, these groups are also formed with regard to specific issues, such as the LSG for the 2008 Olympics set up by the State

⁵ Swaine, Michael D. (2012). "China's Assertive Behavior Part Three: The Role of the Military in Foreign Policy". China Leadership Monitor No. 36. Hoover Institution.

⁶ The practice of creating Leading Small Groups has become so relevant for China's policymaking processes, that these groups are now considered the most important national coordinating bodies and the centres of cross-ministry negotiation and consultation. Miller, Alice (2008). "The CCP Central Committee's Leading Small Groups". China Leadership Monitor No. 26. Hoover Institution.

Council, or the LSG for the Lunar Probe Project, jointly established by the State Council and the Central Military Commission of the CCP in February 2004.⁷

Considering the widespread utilisation of LSGs for the management of sensitive issues and the political, economic, and strategic significance that space activities have for China, it is highly plausible to also envisage the existence of a high-level LSG for the overall coordination of space activities.

Notwithstanding the absence of official documents and the dearth of extensive analysis in this regard,⁸ the necessity and plausibility of a “Space Leading Group” (SLG) is reinforced in particular by the simultaneous involvement of different key stakeholders in the management of the space programme.⁹

Such an SLG would not only be intended to serve as an oversight body and arena for consensus building among the leading members of the relevant government, party, and military agencies; it would also form the core programmatic leadership of China's space programme. The members of the SLG would be senior officials of the CCP, the PLA, and the government, including the prime minister and high-level representatives of the different ministries involved in the programme (e.g. the Ministry of Foreign Affairs, the Ministry of Industry and Information Technology, and the Ministry of Finance).

Like the other LSGs, the SLG is unlikely to formulate concrete policies, but more likely provides the various stakeholders with a series of recommendations and guidelines about the general direction, which the various stakeholders have to respect.

2.1.2 The State Council and SASTIND

Among the major stakeholders under the shadow of an SLG, a primary role would be played by the State Council, which is the highest ranking government organ. The State Council mainly exercises its authority over national space affairs through its ministries and by having the final word on funding decisions for programmes. In addition, the State Council issues the five-year space plan—in the form of a government White Paper—defining the medium-term national strategy in space.

⁷ *Ibid.*

⁸ Only little analysis in the literature has so far acknowledged the possible existence and role of a Space Leading Group. One of the first is provided by the Chinese scholar Yanping Chen in an article published by *Space Policy* in 1993 (“China's space commercialisation effort. Organisation, policy and strategy”. *Space Policy* Vol. 9 (1). 1993: 45–53). The SLG is also mentioned, although not extensively explained in the books of Joan Johnson-Freese (*The Chinese Space Program. A Mystery Within a Maze*. Krieger Publishing Company, Malabar, 1998) and Brian Harvey (*China in Space. The Great Leap Forward*. Springer, New York, 2013).

⁹ The likelihood of an SLG is also reinforced by the acknowledged creation of an ad hoc LSG for the management of specific highly sensitive space projects like Shenzhou and Chang'e.

The State Administration on Science, Technology and Industry for National Defence (SASTIND) is the main administrative body under the State Council tasked with coordinating and managing the country's space activities. It was created through the March 2008 reforms of the State Council that “consolidated and rearranged a number of existing government bodies into larger ‘super-ministries’”.¹⁰ These reforms dismantled the Commission on Science, Technology and Industry for National Defence (COSTIND) and shifted most of its responsibilities and personnel to the newly established SASTIND.

Unlike COSTIND, SASTIND is no longer an organisation under the direct authority of the State Council, but has become part of the super-Ministry of Industry and Information Technology (MIIT). Its main role is to act as the administrative and regulatory hub for the general aspects of China's defence and aerospace industry (in particular development, procurement, and supply). Concretely, SASTIND issues space and defence industry regulations and monitors their implementation, allocates R&D funds through research programmes—which are supervised in collaboration with the Ministry of Science and Technology (MOST) and presumably also with the Ministry of Finance (MOF)—and determines which enterprises may or may not engage in the research and production of aerospace technologies and systems.¹¹ Specifically, with regard to space activity administration, SASTIND also plays an important role in terms of coordinating space policy and plans for the State Council; it is in charge of executing the main space-related regulations, including the “Measures for the Administration of Registration of Objects Launched into Outer Space”.¹²

2.1.3 *The China National Space Administration*

Under SASTIND in the hierarchy, the China National Space Administration (CNSA) formally holds responsibility for “defin[ing] the national space policies, administer[ing] the civilian space programme and manag[ing] the development of

¹⁰ Francis, Ed, and Susan M. Puska (2010). “Contemporary Chinese Defense Industry Reforms and Civil-Military Integration in Three Key Organizations”. Study of Innovation and Technology in China. Policy Brief No. 5. Web. <http://igcc.ucsd.edu/assets/001/500870.pdf>. Accessed 18 January 2014.

¹¹ *Ibid.*

¹² In the measures, it is for instance specified that COSTIND (SASTIND) is in charge—together with Ministry of Foreign Affairs—of the national registration of space objects (art. 4). SASTIND is also responsible for maintaining the National Register. See “Measures for the Administration of Registration of Objects Launched into Outer Space”. Unofficial translation by the Faculty of International Law of China University of Science and Law. 8 February 2001. Available at: http://www.spacelaw.olemiss.edu/library/space/China/Laws/JSL_33.2_China%20Law.pdf. For a commentary, see Ling, Yan (2008). “Comments on the Chinese Space Regulations”. Chinese Journal of International Law. Vol. 7 (3). Web. <http://chinesejil.oxfordjournals.org/content/7/3/681.full.pdf>.

national space science, technology and industry”.¹³ Although CNSA appears on paper to be a fully fledged national space agency, it would be erroneous to consider it as such. In spite of having a name similar to that of its better-known US counterpart, the CNSA in fact is not an all-encompassing space agency, tasked with similar responsibilities and functions to those exercised by the space agencies of the major spacefaring nations.

Rather, the CNSA appears to be, in essence, a clearing house carrying out only a few tasks, namely, serving as the public international face of China's space programme and, second, acting as the liaison office between SASTIND and the aerospace industries. It should be recalled that CNSA was established in 1993 along with the China Aerospace Corporation (CAC) to replace the dismantled Ministry of Aerospace Industry. The underlying intention was to provide the country's space programme with a visible governmental face and apparently to separate space-related governmental functions (theoretically to be assigned to the CNSA) from industrial ones (assigned to CAC). In fact, many of the administrative and managerial responsibilities and functions of this defunct ministry have remained inside CAC. As a result, CNSA's role has remained rather narrow: it has ended up operating as a liaison office between SASTIND and CAC, besides serving as the public face of China's space programme internationally, working with foreign national space agencies.

In sum, while CNSA can be seen as China's external space policy organisation, carrying out China's international obligations and representing the country in international organisations and events (e.g. the ISECG), CAC can be seen as a more powerful internal complement, wielding real power over national space programme matters.¹⁴ Perhaps, these two organisations should really be viewed as one large agency which, not by chance, shares both personnel and management, as well as a very similar logo. A more detailed description of CAC (now restructured as CASC and CASIC) and the aerospace industry's role is provided later in this section.

Confirmation of CNSA's limited role comes from the fact that CNSA is not responsible for the elaboration of the Five-Year Guidelines on space activities, these Guidelines falling within the same framework as China's overall national economic development plans and being decided at the highest political level. Even the derived document, the “White Paper on China's space activities”, is not issued by the CNSA but by the State Council on the basis of the targets envisaged in the Five-Year Plan and subsequently released by its Information Office.

¹³ See “Organisation and Functions”. China National Space Administration. 20 February 2013. Web. <http://www.cnsa.gov.cn/n615709/n620681/n771918/index.html>.

¹⁴ Cheng, Dean, and Kerry Murray (2001). “Orbital Dragons: Implications of Chinese Access to Dual-Purpose Space Technologies”. In: Williamson, Ray A. *Dual-Purposes Technologies: Opportunities and Challenges for US Policymaking*. Space Policy Institute. Washington DC.: p.74.

2.1.4 The China Satellite Launch and Tracking Control General

Compared to CNSA, a more substance-orientated organisation under the authority of SASTIND is the China Satellite Launch and Tracking Control General (CLTC). This organisation, headquartered in Beijing, directly controls and oversees the country's space missions and projects, including its launch infrastructure (thus the three launch sites of Xichang, Jiuquan, and Taiyuan and the forthcoming launch centre of Wenchang), as well as the hub of China's telemetry, tracking, and control (TT&C) network, the Xi'an Satellite Control Centre (XSCC).¹⁵ Although the CLTC falls under the civilian authority of SASTIND, it is run by the General Armament Department (GAD) of the PLA for both the military and civil space programmes. This civil–military mixture in the governance of the CLTC can ultimately be regarded as evidence of the aforementioned intricate web of functions and responsibilities surrounding the Chinese space programme. It clearly shows how the different dimensions (civil, military, commercial, and academic) of the programme—although not fully integrated—are hardly distinguishable.¹⁶ Additional information on China's TT&C network, control centres, and launch sites will be provided in Sect. 4.2.

2.1.5 The General Armaments Department of the PLA

The General Armaments Department (GAD) is one of the four departments of the PLA operating under the control of the Central Military Commission (CMC).¹⁷ It is primarily in charge of managing the procurement and acquisition of weapon systems for the PLA and ensuring defence industry core capabilities. These essential tasks, however, give GAD a broad portfolio of administrative functions and responsibilities. Besides acting as the defence industry's main customer, GAD has also widely engaged with the defence and aerospace industry as regulator, in particular in terms of R&D and production programme management. This role is exercised together with SASTIND on a complementary and peer-to-peer basis. It should be noted, however, that, although GAD and COSTIND were once of equal bureaucratic rank, since the March 2008 reforms and the subsequent subordination

¹⁵ “China Satellite Launch and Tracking Control General”. Nuclear Threat Initiative. 20 January 2014. Web. <http://www.nti.org/facilities/124/>.

¹⁶ Solomone, Stacey (2013). *China's Strategy in Space*. Springer, New York: p. 21.

¹⁷ The other three departments are the General Staff Department, the General Political Department, and the General Logistics Department.

of SASTIND to the MIIT, the new protocol parity is no longer between GAD and SASTIND, but between GAD and MIIT.¹⁸

In collaboration with SASTIND, GAD issues defence industry regulations and monitors their implementation; allocates R&D funds through research programmes, such as the 863 programme, supervised in collaboration with the Ministry of Science and Technology (MOST); and determines which enterprise may or may not engage in the research and production of space technologies and systems.¹⁹

Besides sharing responsibility for the R&D and production programmes of China's aerospace sector and for the administration of space-related infrastructure with SASTIND, GAD is directly responsible for the development of military space capabilities. It also takes part in the management of sensitive space programmes, like human spaceflight. The China Manned Space Engineering (CMSE) Office, which is the bureau of an ad hoc LSG established to manage the Shenzhou manned spaceflight programme, is not by accident headed by a representative of GAD.

This active involvement of the PLA in the management and execution of China's space programme has obviously raised serious concerns and led many Western analysts to assert that the role of the PLA is ultimately the overwhelming one. Reports produced by the *US–China Economic and Security Review Commission* issued for the US Congress have repeatedly emphasised this aspect.²⁰

This claim can be considered accurate insofar as the key infrastructural elements (like launch and tracking facilities) are run and staffed by the military, and a highly visible endeavour such as human spaceflight sees its direct involvement. Affirming that projects are run by the PLA, however, does not automatically imply that they are ultimately decided on and controlled by the military. In fact, not only are core responsibilities shared with other leading stakeholders (e.g. SASTIND, the MOST, and CAS), but key decisions on the implementation of space policies and the overall direction of the programme ultimately reside in the hands of the high-level decision makers of the Party.²¹

In this regard, it must be emphasised that the PLA is far from being an autonomous and independent player within the power structures of the PRC. As mentioned, the GAD is one of the four departments of the PLA operating under the control of the Central Military Commission (CMC) of the CCP, which is the leading organ of the armed forces within the Communist Party. The fact that Xi Jinping,

¹⁸ Francis, Ed, and Susan M. Puska. (2010) "Contemporary Chinese Defense Industry Reforms and Civil-Military Integration in Three Key Organisation". Study of Innovation and Technology in China. Policy Brief No. 5. Web. <http://igcc.ucsd.edu/assets/001/500870.pdf>. Accessed 18 January 2014.

¹⁹ *Ibid.*: pp. 2–3.

²⁰ US–China Economic and Security Review Commission. 2011 Annual Report to Congress. US Government Printing Office, Washington DC, United States. November 2011.

²¹ For this interpretation, see also Kulacki, Gregory, and Jeffrey Lewis. (2009). *A Place for One's Mat: China's Space Program, 1956–2003*. American Academy of Arts and Sciences, Cambridge, MA. See also Harvey, Brian (2013). *China in Space. The Great Leap Forward*. Springer, New York.

president of the PRC and chairman of the CCP, also holds the position of chairman of the CMC not only shows the close interconnection between the Army and the Party but is also a significant piece of evidence of the overall subordination of the military to the party political leadership.

In addition, the orientation given by the CMC on the development of space competences does not necessarily indicate that there is a clear priority given to the military component of the space programme.²² GAD participation in a number of relevant space endeavours concretely serves as a catalyst for faster and broader innovation throughout the PLA, as well as for spurring civil–military integration in the Chinese defence, science, technology, and industry system,²³ but cannot be portrayed as the specific, ultimate goal of China’s space programme.

Furthermore, it should be noted that possible cooperation with China in human spaceflight does not automatically imply cooperation with its military: indeed, scientists of the China’s Academy of Science have for instance already cooperated with German researchers on SIMBOX, a package of biological and medical experiments launched on board the Shenzhou-8 spacecraft in 2011. In addition, the scientific community is planning joint cooperative undertakings in the forthcoming second space laboratory (e.g. the POLAR experiment with Switzerland, France, and Poland and the SVOM mission with CNES).²⁴

In conclusion, it would seem more appropriate to reverse the perspective proposed by the scholar Dean Cheng by affirming that one of the myths surrounding China’s space programme is that “it is military in nature”.²⁵

2.1.6 The Aerospace Industry

In an almost symbiotic relationship with SASTIND, GAD, and the central government, China’s aerospace industries occupy a key position in the overall organisational structure of China’s space activities. As mentioned, not only do they make up the backbone of China’s space programme through the provision of space technologies and systems; they also act as proactive and fully fledged players, wielding real power in the administration of space activities and exerting primary

²² Rathgeber, Wolfgang (2007). “China’s Posture in Space. Implications for Europe”. ESPI Report 3. European Space Policy Institute, Vienna: p. 32.

²³ Francis, Ed, and Susan M. Puska. (2010) “Contemporary Chinese Defense Industry Reforms and Civil-Military Integration in Three Key Organisations”. Study of Innovation and Technology in China. Policy Brief No. 5. Web. <http://igcc.ucsd.edu/assets/001/500870.pdf>. Accessed 18 January 2014.

²⁴ Harvey, Brian (2013). *China in Space. The Great Leap Forward*. Springer, New York: p. 18 and p. 359.

²⁵ Cheng, Dean. “Five Myths about China’s Space Program”. The Heritage Foundation. 29 September 2011. Web. <http://www.heritage.org/research/reports/2011/09/five-myths-about-chinas-space-program>.

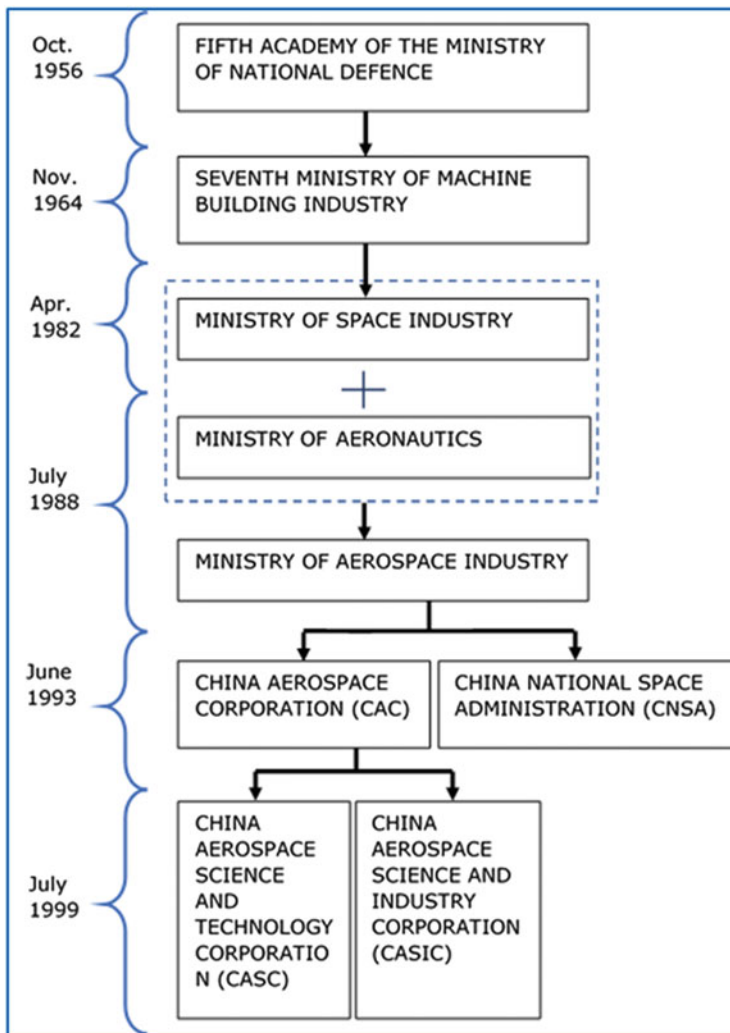


Fig. 2.1 Evolution of China's aerospace industry (author's visualisation)

control over the execution of the space programme in terms of day-to-day operations. As State-Owned Enterprises (SOEs), it should be recalled that they originated as governmental entities that were eventually transformed into actual enterprises, but a large part of their former administrative responsibilities and functions has nonetheless remained in their hands (see Fig. 2.1).

Currently, there are two huge state-owned industrial groups that are actively involved in the administration and execution of China's space programme:

- The China Aerospace Science and Technology Corporation (CASC)
- The China Aerospace Science and Industry Corporation (CASIC)

Both CASC and CASIC were officially set up in July 1999, when the CAC, established in 1993, was once again restructured and split into these two large conglomerates. It merits note, however, that CAC too was the result of a long-standing process of transformation started in October 1956 with the creation of the Fifth Academy of the Ministry of National Defence. In 1965, this academy became an autonomous ministry (the Ministry of the Seventh Machinery Industry) and subsequently went through numerous organisational and name changes that include the Ministry of Space Industry (in 1982), the Ministry of Aerospace Industry (in 1988), and the final transformation into a real corporation in 1993 when the ministry was split into CNSA and CAC.²⁶ This evolutionary path deserves attention, as it captures well the reason for arguing that CASC acts as the actual “operating agency” of the country’s space programme.

It is quite likely that the driver behind the restructuring approved in July 1999 was the twofold effort of China’s “New Right” policymakers to create a more organic partition between the defence industry (CASIC)²⁷ and the space industry (CASC) and to loosen the state’s control over the running of enterprises in order to spur innovation and inject some degree of competition into the aerospace and defence industry, thus strengthening overall procurement for space technologies and systems. The ultimate outcome, which still appears to be a work in progress, can nevertheless be seen as a half success for the “New Right”: although both the CASC and CASIC aerospace industries are no longer directly government-managed companies, they nonetheless remain government owned and controlled. Indeed, the two corporations still need to report directly to the Central Government, which exercises control through three agencies: the State-owned Assets Supervisions and Administration Commission (SASAC) of the State Council²⁸ and the previously described SASTIND and GAD.

2.1.6.1 CASC

CASC is a large-scale conglomerate of more than 130 companies and industrial plants scattered nationwide and employing more than 140,000 staff.²⁹ As the main contractor of China’s space programme, CASC is primarily engaged in the research, design, manufacture, and supply of space technologies and systems, as well as in the provision of international commercial satellite launch services. The conglomerate comprises eight major R&D and production complexes—each of

²⁶ “History of CASC”. China Aerospace Industry Corporation. Web. <http://english.spacechina.com/n16421/n17138/n382513/c386575/content.html>. Accessed 20 February 2014.

²⁷ For more information on the so-called New Right policymakers, see Sect. 5.2.

²⁸ For a description of the role of SASAC, see “Main functions and responsibilities of SASAC”. State-owned Assets Supervisions and Administration Commission. Web. <http://www.sasac.gov.cn/n2963340/n2963393/2965120.html>. Accessed 20 February 2014.

²⁹ “Company profile”. China Aerospace Science and Technology Corporation. Web. <http://english.spacechina.com/n16421/n17138/n17229/c127066/content.html>. Accessed 20 February 2014.

them having their own research institutes, manufacturing plants, and commercial enterprises—14 specialised companies, nine listed companies, and a number of subordinate units.³⁰ The eight major complexes, which form the backbone of CASC and are often referred to as academies, thanks to their close connection with the China Academy of Science (CAS), are:

- China Academy of Launch Vehicle Technology (CALT)
- China Academy of Space Technology (CAST)
- Shanghai Academy of Spaceflight Technology (SAST)
- Academy of Aerospace Solid Propulsion Technology (AASPT)
- Academy of Aerospace Liquid Propulsion Technology (AALPT)
- Sichuan Academy of Aerospace Technology (SAAT)
- China Academy of Aerospace Electronics Technology (CAAET)
- China Academy of Aerospace Aerodynamics (CAA)

Among these academies, CAST, CALT, and SAST are the most prominent. CAST is the primary R&D and production complex that designs and manufactures scientific and applications satellites. Like the other academies, CAST has a significant infrastructure, with a number of subordinate institutes, centres, and factories.³¹ CALT and SAST are mainly involved in the overall research, design, development, manufacturing, and testing of the Long March (LM) Launch Vehicles, manned spacecraft, and related products. Usually referred to as the Beijing and Shanghai “bureaus” of China’s space programme, the two academies are sometimes regarded as competing organisations. In order to have a harmonised and balanced “distribution of work and responsibilities”, competences have been carefully distributed between the two. With regard to the development of the next generation of LM vehicles, it can be noted that, whereas SAST has been assigned the development of the LM6 and LM7, the Beijing-based CALT acts as the primary stakeholder for development of the future heavy and super-heavy rockets: the LM5 and the LM9, respectively (see Sect. 4.2).

Besides these eight large R&D and production complexes, CASC exercises control over a number of specialised companies. Among them, a significant role is played by the China Great Wall Industry Corporation (CGWIC). Established in 1980, CGWIC “is the sole company authorised by the government to provide commercial satellite launch services and space technology to international clients”.³² As a large corporation, CGWIC also has a number of subsidiary companies. Other specialised companies of CASC include the China Satellite Communication

³⁰ *Ibid.*

³¹ For detailed examination of CAST, see Harvey, Brian (2013). *China in Space. The Great Leap Forward*. Springer, New York: pp. 52–53.

³² *Cit.* “Company profile”. China Great Wall Industry Corporation. Web. <http://www.cgwic.com/About/index.html>. Accessed 20 February 2014. See also “China Great Wall Industry Corporation (CGWIC).” Nuclear Threat Initiative. Web. <http://www.nti.org/facilities/50/>. <http://www.cgwic.com/Partner/>. Accessed 20 February 2014.

Corporation, the China Aerospace Engineering Consultation Centre, and the China Aerospace Electronics Corporation.

Overall, the organisational structure of CASC reveals a high degree of complexity; a graphical representation can be found in Appendix C, which reinforces the aforementioned argument about CASC acting largely as a national space agency.

2.1.6.2 CASIC

Like CASC, CASIC is a huge conglomerate of more than 140 companies, factories, and R&D institutes scattered nationwide. These are comprised of seven main academies, two research and production bases, and six publicly listed companies, which employ 135,000 people, 40 % of whom are specialists and technicians.³³

Although CASIC acts as the main contractor of China's aerospace defence programme and is particularly focused on the production of short- and medium-range ballistic missiles and cruise missiles, it also plays an active part in many space endeavours. Through its subsidiaries, a large number of stand-alone technologies and products, industrial basic parts, electronic components, and software testing and evaluation services have been provided for the Chang'e lunar exploration and the BeiDou satellite navigation programmes. In addition, CASIC has provided ground-to-space integrated support for each of the ten spaceflights undertaken by the Shenzhou missions, including technical support for their accurate injection into orbit, precise docking, stable operation, and safe return. CASIC radar equipment and technology are also used in meteorological observations and for the ground receiving system.³⁴ Compared to CASC, however, CASIC's overall role remains less substantial and not so completely entrenched in the overall governance of the Chinese space programme.

2.1.7 *The Chinese Academy of Sciences*

The Chinese Academy of Sciences (CAS) is an additional and very relevant player in the scheme of China's space activities. Established immediately after the CCP takeover of China (on 1 November 1949), from the outset CAS has been assigned with the responsibility for providing S&T consultations for the nation's decision-making and leading the nation's S&T development. CAS is a prestigious and vast institution, numbering roughly 60,000 regular staff, 79.9 % of whom are

³³ "Introduction to CASIC". China Aerospace Science and Industry Corporation. Web. <http://english.casic.cn/n189298/n189314/index.html>. Accessed 21 February 2014.

³⁴ "Footprints in Space". China Aerospace Science and Industry Corporation. Web. <http://english.casic.cn/n189300/n1547687/index.html>. Accessed 21 February 2014.

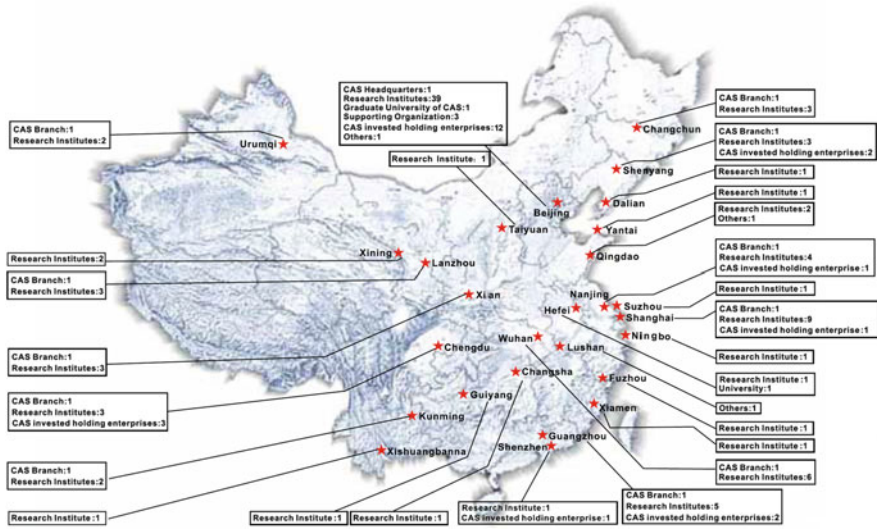


Fig. 2.2 Distribution of CAS institutions (*Source: CAS*)

professional and technical employees.³⁵ There are 124 institutions directly under its authority, with 104 research institutes, five universities and supporting organisations, 13 management organisations featuring headquarters and branches in China's major cities, and three other units. Moreover, there are 25 legal entities affiliated with it and 22 holding companies with CAS investment,³⁶ the most well-known being Lenovo.³⁷ Research is organised along six divisions: mathematics and physics, chemistry, life sciences and medical sciences, Earth sciences, information technology sciences, and technological sciences. A map illustrating the distribution of CAS institutions is presented in Fig. 2.2.

As the highest academic institution for S&T and the linchpin of China's overall S&T planning, CAS has been playing a crucial role also in regard to the space programme. This role has manifested itself both in terms of influence exercised on the decision-making process and in terms of concrete management of a number of space-related programmes. As the analysis of the Shenzhou manned spaceflight and Chang'e lunar exploration programmes will show (see Sect. 4.2), CAS scientists

³⁵ "Directory of the CAS Subordinate Institutions". Chinese Academy of Sciences. Web. <http://english.cas.cn/CASI/In/200909/P020120813569850110467.pdf>. Accessed 21 February 2014.

³⁶ "CAS Institutions". Chinese Academy of Sciences. Web. <http://english.cas.cn/CASI/>. Accessed 21 February 2014.

³⁷ The CAS holds a 36 % stake in Legend Holdings Ltd., which is Lenovo's largest shareholder with a 32.5 % stake. Osawa, Juro and Lorraine Luk. "How Lenovo Built a Chinese Tech Giant". Wall Street Journal. 30 January 2014. Web. <http://online.wsj.com/news/articles/SB10001424052702303973704579352263128996836>. Accessed 22 February 2014.

have often turned into policy entrepreneurs, proposing ideas, setting agendas, and implementing policy within the national space programme.³⁸

This influence is primarily wielded through the prestige CAS holds at national level and is reinforced by its independence from the ministries and its direct connections to the State/Party authorities. In fact, it is worth-noting that CAS does not report back to the MIIT or the Ministry of Science and Technology, the Academy being an institution under the direct authority of the State Council.

Through the work of its research institutes, CAS also exercises a substantial role in space programme management. Among the numerous institutes under CAS authority that are more visibly involved in the overall execution of China's space programme are:

- The Institute of Remote Sensing and Digital Earth (RADI), which was established in November 2012, through the merging of two CAS institutes: the Institute of Remote Sensing Applications (IRSA) and the Centre for Earth Observation and Digital Earth (CEODE). RADI focuses on the construction and operation of major earth observation infrastructure and the air-space-ground integrated earth observation technology system.³⁹
- The National Space Science Centre (NSSC), which is the key national institute responsible for planning, selecting, developing, and managing the operation of China's space science satellite missions.⁴⁰
- The National Astronomical Observatories of the Chinese Academy of Sciences (NAOC): this institution was officially founded in April 2001 through the merger of four observatories, three observing stations, and one research centre, all of which were suborganisations of CAS. NAOC is headquartered in Beijing, with four subordinate units distributed across the country: Yunnan Observatory, Nanjing Institute of Astronomical Optics and Technology, Urumqi Observatory (now called Xinjiang Astronomical Observatory), and Changchun Observatory. Purple Mountain Observatory (PMO) and Shanghai Astronomical Observatory (SHAO) are separate institutes of CAS, but are subject to the same academic strategies and research policies as NAOC.⁴¹
- The Shanghai Institute of Micro-systems and Information Technology, which had major responsibility for the development of microsattellites, including the *Chung Xin* (literally "Innovation") store-and-forward communications

³⁸ Even the decision to create the BeiDou national satellite navigation system resulted from the efforts of a core group of scientists of CAS. Bessa, Patrick (2010). "Policy making in China's space program: A history and analysis of the Chang'e lunar orbiter project". *Space Policy* Vol. 26 (4): 214–221.

³⁹ "Institute of Remote Sensing and Digital Earth-Chinese Academy of Sciences". Chinese Academy of Sciences. Web. <http://english.irsas.cas.cn/>. Accessed 18 February 2014.

⁴⁰ "National Space Science Centre-Chinese Academy of Sciences". Chinese Academy of Sciences. Web. <http://english.nssc.cas.cn/au/mfdg/>. Accessed 18 February 2014.

⁴¹ "National Astronomical Observatories Chinese Academy of Sciences". Chinese Academy of Sciences. Web. <http://english.nao.cas.cn/au/history/>. Accessed 21 February 2014.

microsatellite, is also focused on systematic core technology innovation and microsatellite integration innovation.

The existence of a large number of institutes under CAS that are tasked with concrete management responsibilities creates additional complexities in the attempt to draw a clear picture of “who is in charge” of China’s space activities. The institutes and R&D centres do not report to SASTIND via the CNSA, but only to CAS management organisations.

2.1.8 Other Space-Related Organisations

Finally, there are a number of separate administrative entities and organisations that do not directly fall within the frame of the principal space players presented so far, but are nonetheless involved in the overall management of China’s space activities. Noteworthy among them are:

- The China Meteorological Administration (CMA),⁴² which is inter alia responsible for the procurement and operation of China’s meteorological satellites and for the organisation of meteorological research projects. CMA reports directly to the State Council.
- The China Satellite Navigation Project Centre, which is in charge of the design, development, and operation of the BeiDou/COMPASS navigation system and comprises two main departments: the project management department and the general technology department.⁴³
- The National Satellite Oceanic Application Center (NSOAS), which operates under the jurisdiction of the State Oceanic Administration and is mainly responsible for development and data processing of the *Hai Yang* oceanographic satellite series, as well as for the development and provision of satellite oceanographic applications.⁴⁴
- The National Remote Sensing Centre of China (NRSCC), an entity under the MOST, which is in charge of planning and overall policy decisions on remote sensing technology and its industrialisation.⁴⁵

⁴² CMA is a large-scale organisation employing 52,988 staff members and accounting for 2300 bureaus nationwide. “China Meteorological Administration”. China Meteorological Administration Web. http://www.cma.gov.cn/en/aboutcma/introduction/201203/t20120319_166488.html. Accessed 18 February 2014.

⁴³ “BeiDou Navigation Satellite System”. Web. <http://en.beidou.gov.cn>. Accessed 22 February 2014.

⁴⁴ “National Satellite Oceanic Application Center”. Web. http://www.nsoas.gov.cn/NSOAS_En/index.html. Accessed 21 February 2014.

⁴⁵ “National Remote Sensing Centre of China”. Web. <http://www.nrscc.gov.cn/nrscc/en/functions/>. Accessed 23 February 2014.

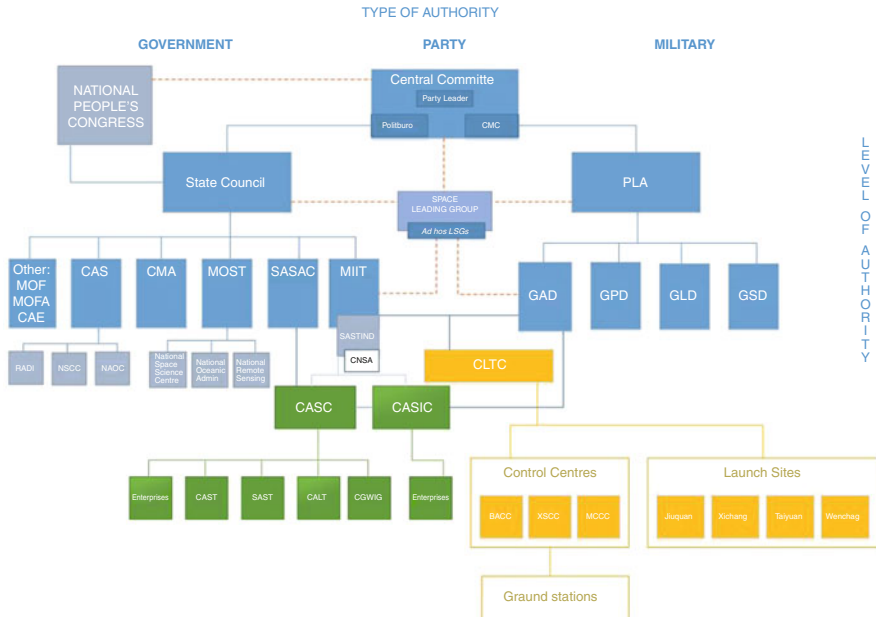


Fig. 2.3 Organisation of Chinese space activities (author’s visualisation)

2.1.9 An Overview

As shown, there are many players involved in the governance of Chinese space activities. Their interplay creates an intricate web in policymaking processes of programmes, R&D, and related activities and hampers any attempt to separate the different dimensions (civil, military, academic, commercial) of China’s space programme. Furthermore, it should be noted that whereas this section has only provided an assessment of the functions and responsibilities of the most important, large, and directly involved entities, other actors are presumably playing important roles, and new bodies will doubtless be set up.

In order to shed some light on this maze, a graphical representation showing the interconnections and inter-responsibilities between the major players in the organisational structure of China’s space programme is presented in Fig. 2.3. Notwithstanding its possible inaccuracy, this organigram can nonetheless be of some help in understanding China’s space programmes; it should thus contribute to eliminating some of the frequent and prevailing misinterpretations in the majority of Western assessments.

Hopefully, the ever-present reticence among Chinese policymakers about divulging information to foreigners will in the future decrease, as organisational secrecy does not support the Chinese goal of increasing international cooperation.⁴⁶

⁴⁶ See Johnson-Freese, Joan (1998). *The Chinese Space Program. A Mystery Within a Maze*. Krieger Publishing Company, Malabar, FL.

2.2 Space Activities Budget

China does not publish official figures on its overall space spending. This dearth of information, combined with the previously described opacity in structures and organisation, makes obtaining reliable data on the expenditure and budget allocation for space-related activities difficult.

It would, however, be too simplistic to attribute the lack of an official budget for space activities solely to a desire for secrecy motivated by the sensitive nature of this domain. The existence of an official budget for defence and the fact that figures are often provided for single projects corroborate the idea that there is more to it than this.⁴⁷ Perhaps, one of the contributing causes of the dearth of information lies in the “multichannel system” of funding that is created by the numerous actors involved in the management of space projects and R&D tasks (the Government, CAS, GAD, the SOEs, etc.). The explanation is probably not one dimensional.

In order to have an idea of the total annual spending on space activities in China, it is thus necessary to rely on estimates. A variety of estimates have been offered in the literature, and different methodologies have been proposed. One of the most recognised approaches to estimating the Chinese space budget is that proposed by the Space Foundation in its Space Report, which suggests comparing China to its “peers”. On average, the major spacefaring nations—excluding the United States and Russia, where spending is significantly higher than in *any* other country—devote approximately 0.042 % of their current-price Gross Domestic Product (GDP) to civil space activities.⁴⁸

Using this method and China's 2012 current-price GDP of 51,894.20 trillion yuan (US\$ 8227 billion),⁴⁹ the country's 2013 space spending can be estimated at 21.80 billion yuan (\$3.50 billion) (see Table 2.1 for the estimated budget for China's space programme over the past few years).⁵⁰

Similar estimates have been provided through research conducted by other institutions, such as Euroconsult and the European Space Directory, thus confirming a baseline of at least \$3 billion for China's total space budget.

⁴⁷ The cost of project 921, for instance was given as ¥18 billion (about 1.5 billion €), of which ¥8 billion covered new facilities and ¥10 billion the development of Shenzhou. Later they quoted costs for an unmanned Shenzhou launch of ¥800 million and manned at ¥1 billion (80 million € and 100 million €, respectively). The cost of Chang'e up to 2012 was given as ¥2.3 billion (230 million €). Harvey, Brian (2013). *China in Space. The Great Leap Forward*. Springer, New York.

⁴⁸ The Space Foundation (2013). *The Space Report 2013 | The Authoritative Guide to Global Space Activity*. The Space Foundation, Colorado Springs. See also ESD Partners (2013). *European Space Directory*. ESD Partners Publication, Paris.

⁴⁹ Source: “GDP (current US\$)”. The World Bank (2014). Web. <http://data.worldbank.org/indicator/NY.GDP.MKTP.CD>. Accessed 13 February 2014.

⁵⁰ “World Economic Outlook Database.” International Monetary Fund (2014). Web. <http://www.imf.org/external/pubs/ft/weo/2013/02/weodata/index.aspx>. Accessed 24 February 2014.

Table 2.1 China's space budget (in current US\$ billion)

Year	2010	2011	2012	2013
GDP growth (%) ^a	10.4	9.3	7.7	7.7
GDP (current \$ billion) ^b	5930.5	7322.0	8227.1	8860.6
Space budget (0.042 % of the previous year GDP, in \$ billion)	2.1	2.5	3.1	3.5

^a“Regional Outlooks. East Asia and the Pacific.” The World Bank (2014). Web. <http://www.worldbank.org/en/publication/global-economic-prospects/regional-outlooks/eap>. Accessed 13 February 2014

^b“GDP Annual Growth Rate | Forecast.” The World Bank (2014). Web. <http://www.tradingeconomics.com/forecast/gdp-annual-growth-rate>. Accessed 13 February 2014

The table relates budgetary growth to overall economic performance. It shows that the budget has consistently increased in the past few years, moving from \$2.1 billion in 2010 to \$3.5 billion in 2013 and thus accounting for a growth of \$1.4 billion over only 3 years. In line with the overall economic growth rates, the rate of expansion of China's space programme is considerable; however, if compared to the size of its national economy, the overall investment appears quite modest.

It bears noting in this regard that the above methodology could present several pitfalls. First, it should be asked whether China can be treated as a “normal spacefaring nation” with a space budget that represents only 0.042 % of its GDP and whether the space budget is merely linked to the growth of the economy or must be assumed to represent a deeper political—and thus financial—involvement. In addition, it is not clear whether the estimates provided using this method are inclusive of infrastructure-related expenditures,⁵¹ development costs, or military programmes. Finally, and more importantly, these estimates do not take into account the difficulties related to currency exchange rates, cost of living/cost of labour, and specific market prices.

Since labour and manufacturing costs are rather low in China, as are market prices, it thus appears to be more useful to convert Chinese expenditures utilising Purchasing Power Parity (PPP) rates. Notwithstanding that the consistency of this method can also be questioned, the utilisation of a current international dollar—a hypothetical currency with the same purchasing power of goods that the US dollar had in the United States at a given point in time—gives a better idea of the actual size of China's space programme (see Table 2.2).

⁵¹ Many analysts do not include infrastructure-related expenditures in the overall budget—i.e. the expenditures for the launching facilities, the tracking systems, and the testing facilities.

Table 2.2 China's space budget (billion \$)

Year	2010	2011	2012	2013
GDP (current \$)	5930.4	7322.0	8221.0	8854.0
PPP GDP (international \$) ^a	10,039.9	11,189.1	12,261.3	13,205.4
China's space budget	2.1 ^b	2.5	3.1	3.5
China's PPP space budget	3.8 ^c	4.2	4.7	5.1

^a“Regional Outlooks. East Asia and the Pacific.” The World Bank (2014). Web. <http://www.worldbank.org/en/publication/global-economic-prospects/regional-outlooks/eap>. Accessed 13 February 2014

^b0.042 % of the previous year GDP, in \$ billion

^c0.042 % of the previous year PPP GDP, in \$ billion

2.2.1 Budget Breakdown

Assessing the budget breakdown is also quite problematic, given that few figures are available. In addition, these figures are similarly complicated by currency rates, different market prices, and how inclusive they are of military programmes, development costs, and commercial revenues. In light of these obstacles, the figures should be treated with extreme caution.

According to the analysis provided by *Euroconsult*, one of the most authoritative sources in this regard, the expenditure split between civil and defence space programmes can be estimated at 58 % and 42 % (US\$ 2.022 billion and 1.410 billion, respectively, out of a total budget of US\$ 3.432 billion).⁵²

Although the percentage dedicated to military-related space activities appears impressive, it has to be underlined that the supposed budget managed by the PLA includes expenditure for the human spaceflight and launcher programmes, which represent the first and third largest items of China's total space budget.⁵³ Expenditure specifically dedicated to space security (mainly Space Situational Awareness) is, on the other hand, estimated to represent less than the 0.3 %. At the same time, programmes financed by the civil budget (e.g. earth observation and navigation) are dual-use systems benefitting also the PLA.

Separating military programmes from civil ones can thus be quite difficult: budget composition by application might be more meaningful. A graphical representation is therefore provided in Fig. 2.4.

With \$790 million allocated in 2012, human spaceflight represents the largest budget item, roughly one quarter of China's total space budget.⁵⁴ It can be anticipated that budget growth in this domain will continue in order to ensure proper investment for the planned launch of a second space laboratory in 2015 and the

⁵² For figures elaborated on the data provided by Euroconsult, see Euroconsult (2013). *Government Space Markets—World Prospects to 2022*. Fourth Edition. A Euroconsult Research Report, Paris.

⁵³ *Ibid.*

⁵⁴ *Ibid.*

Budget Breakdown 2012	USD million	Percentage
Civil	2022	58%
Defence	1410	42%
Manned Spaceflight	790	23.02%
Earth Observation	769	22.41%
Launcher	620	18.07%
Science & Exploration	479	13.96%
SatNav	416	12.12%
Other	216	6.29%
SatCom	132	3.85%
Space Security	10	0.29%
Total	3432	100.00%

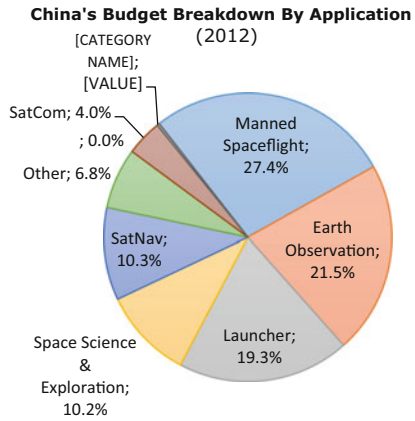


Fig. 2.4 Budget breakdown 2012

construction of a large space station by 2022.⁵⁵ The second largest budget is for the earth observation programme (\$769 million allocated in 2012). There are currently four systems in operation and a bilateral programme with Brazil (see Sect. 3.1.3). The size of the EO programme expenditure will likely continue to expand, considering that roughly 30 EO satellites are expected to be launched by 2022.

Accounting for 18 % of the total budget, the launcher segment is the third largest budgetary item in the programme (\$620 million); a budgetary augmentation can be also expected in this domain, given the ongoing development of a new launcher family (see Sect. 3.3.1).

2.2.2 China's Space Budget in Comparative Perspective

Beside the *absolute* numbers and the budget breakdown of China's space programme, the *relative* position China has when setting its budget in a comparative international perspective is also quite significant. Table 2.3 depicts the space-related expenditures of the major spacefaring nations and their respective global ranking.

⁵⁵ Jones, Morris. "The Next Tiangong". Space Daily. 3 March 2014. Web. http://www.spacedaily.com/reports/The_Next_Tiangong_999.html. Accessed 3 March 2014. See also Lan, Chen, and Jacqueline Myrrhe (eds). *Go Taikonauts. All about China's space programme*. Issue 10. December 2013: pp. 31–33.

Table 2.3 Estimated government space budget (2012)

Country	Rank	Space report and ESD ^a (€)	Space report and ESD (\$)	Euroconsult (\$)
United States ^b	1	37.160 billion €	\$47.911 billion	\$42.689 billion
Europe ^c	2	6.193 billion €	\$7.985 billion	\$9.606 billion
Russia	3	3.596 billion €	\$4.636 billion	\$8.597 billion
Japan	4	2.616 billion €	\$3.373 billion	\$3.699 billion
China	5	2.397 billion €	\$3.090 billion	\$3.432 billion
India	6	0.938 billion €	\$1.210 billion	\$1.259 billion
Canada	7	0.318 billion €	\$0.411 billion	\$0.618 billion

^aThe Space Foundation (2013). *The Space Report 2013 | The Authoritative Guide to Global Space Activity*. The Space Foundation, Colorado Springs. ESD Partners (2013). *European Space Directory*. ESD Partners Publication, Paris

^bUS space spending includes the budget of NASA and that of the Department of Defence

^cEurope's budget includes all contributions to ESA (EU, EUMETSAT, and Cooperating States, but Canada excluded) and all national space expenditures of ESA Member States

Table 2.4 Number of launches 1957–2013^a

Country	1957–2013	2007–2010	2011	2012	2013
Russia	2998	119	30	24	32
United States	1439	71	17	13	19
Europe	221	25	5	10	7
China	188	41	18	19	15
Japan	84	8	3	2	3
India	33	9	3	2	3
Total	4965	272	77	70	79

^aElaboration of the data provided by the US Federal Aviation Administration (FAA) for the launches performed between 2007 and 2013 and by Brian Harvey for the launches performed during the period 1957–2011; see Harvey, Brian. *China in Space. The Great Leap Forward*, Springer, New York, 2013

As the table shows, China is estimated to be the fifth largest space spender in the world, lagging far behind not only the United States, but also Russia and Europe, although in a catching-up position with Japan and well ahead of India and Canada. If compared to China's ranking in the global economy (second), the investment appears relatively modest.

As already mentioned, the figures should be treated with extreme caution. Considering the several complications involved in this type of comparison, additional comparative methods may be relevant for capturing China's relative position among the leading spacefaring nations. Particularly meaningful are, for instance, statistics comparing the number of launches. Table 2.4 depicts the launches performed by the major spacefaring nations over the period 1957–2013, with a special focus on the period 2007–2013.

As the table shows, China accounts for only a tiny portion of world launches since 1957. The country lags far behind the leading spacefaring nations, in particular Russia and the United States. However, given that China's ascendancy in space is relatively recent, it is more indicative to look at the last decade, while during the period 1970–2003 the average launch rate was just over two launches a year, since the early 2000s the number has exponentially increased, pushing China into the top-three league of launching states: in 2007, the country outstripped Europe as the third leading nation in terms of launches and in 2011 and 2012 overtook the United States. Considering the impressive number of satellites that China plans to launch in the next few years (see the next section), the number of Russian launches is also likely to be matched. Overall, these statistics place China at the pinnacle of the international space hierarchy, alongside the United States and Russia, although they should not be taken as indicators of the level of operational and technological capabilities compared with other countries. Especially in regard to the United States, parity in terms of financial resources and technological expertise still appears some way off.

2.2.3 China's Space Budget: A Forecast

Finally, it may be relevant to try to forecast the evolution of China's space budget over the next decade. A projection can be made by directly linking the increase in the space budget to the forecasted growth of China's economy, in particular to the estimated GDP growth rate. As before, the figures neither reflect the possible deeper political involvement in space activities nor account for inflation, but only display the pace of growth of China's space budget in relation to its forecasted economic performance to 2030. Both nominal and PPP space budget evolution are considered in Table 2.5.

A graphical representation of Table 2.5 can be found in Fig. 2.5.

Notwithstanding the possible pitfalls, Fig. 2.5 gives quite a good indication of the likely pace of growth of China's space programme. Like its economic growth rate, the space budget can be expected to increase at a Compound Annual Growth rate (CAGR) of 7.5 % between 2013 and 2029, when it will reach the level of roughly US\$10 billion (international \$14 billion in PPP terms). It can be anticipated that such a growth rate will make China the largest space spender in the world, after the United States, by the end of the next decade.

Table 2.5 China's future economic performance and space activities budget (in current US\$ billion)

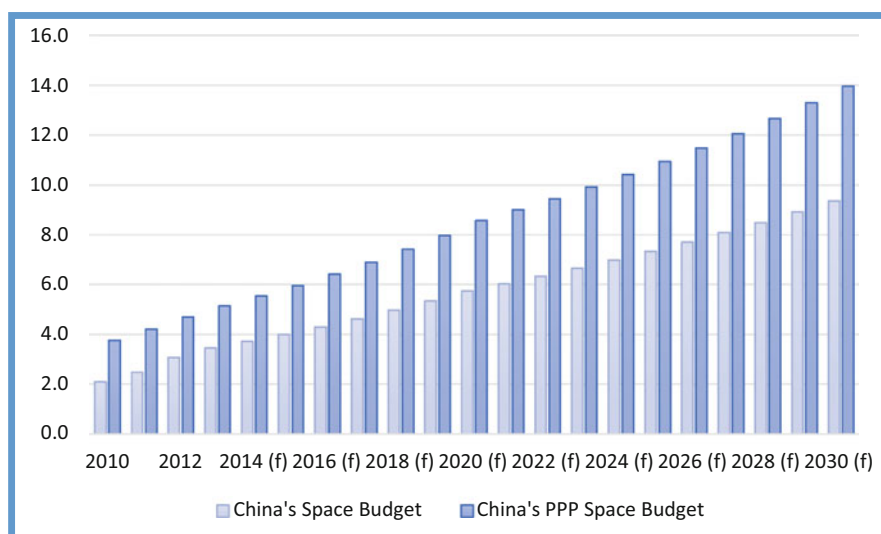
Year	2012(e)	2013(e)	2014 (f)	2015 (f)	2016 (f)	2020 (f) ^a	2030 (f) ^a
GDP growth (%) ^b	7.7	7.7	7.7	7.5	7.5	5.0	4.0
GDP	8221.0	8854.0	9535.8	10,251.0	11,019.8	14,374.4	23,191.3
PPP GDP ^c	12,261.3	13,205.4	14,222.2	15,288.9	16,435.5	21,438.7	34,588.8
Space budget (0.042 % of GDP)	3.1	3.5	3.7	4.0	4.3	5.7	9.4
PPP space budget (0.042 % of PPP GDP)	4.7	5.1	5.5	6.0	6.4	8.6	14.0

e estimated, *f* forecasted

^a2017–2019: 7.5 % GDP growth rate; 2020–2029: 5.0 % GDP growth rate; 2030: 4.0 % GDP growth rate

^b“Regional Outlooks. East Asia and the Pacific.” The World Bank (2014). Web. <http://www.worldbank.org/en/publication/global-economic-prospects/regional-outlooks/eap>. Accessed 13 February 2014. See also “GDP Annual Growth Rate | Forecast.” The World Bank (2014). Web. <http://www.tradingeconomics.com/forecast/gdp-annual-growth-rate>. Accessed 13 February 2014

^c“Regional Outlooks. East Asia and the Pacific.” The World Bank (2014). Web. <http://www.worldbank.org/en/publication/global-economic-prospects/regional-outlooks/eap>. Accessed 13 February 2014

**Fig. 2.5** China's forecasted space budget (in current and current PPP billion \$)

2.3 Space Policy and Targets

Compared to the high level of secrecy that Beijing maintains in its policy processes and the dearth of information provided on its capabilities and budgetary allocation, the overall direction of China's space policy agenda is intentionally more transparent, to a degree.⁵⁶

Traditionally, China's space policy has been articulated in a series of broader socio-economic, S&T, industrial or defence-related development plans, policy papers, and guidelines (e.g. "the National Medium- and Long-Term Plan for the Development of Science and Technology (2006–2020)" issued by the State Council in February 2006, which provides guidelines for leapfrogging China into a leadership role in science-based industry by 2020).⁵⁷

More generally, the space programme has been planned and executed within the framework of China's Five-Year Plans (5YP), the broad coordinating mechanisms of national social and economic planning that have been issued since 1953. Discussed and adopted by the Central Committee of the CCP and subsequently ratified by the National People's Congress, the 5YP provides the grand blueprint of the overall objectives and goals related to social and economic growth and industrial planning in key sectors (e.g. strategic emerging industries such as biotech, information technology, advanced materials, aerospace, etc.) and regions.⁵⁸ Currently, China is in its 12th Five-Year Programme, governing the period from 2011 to 2015.

The specific 5YP for the space sector was announced by China's State Council in the form of a government White Paper, entitled "China Space Activities in 2011".⁵⁹ The paper, released on 29 December 2011, is the third space policy document of this kind, the other two having been issued in 2001 and 2006, in conjunction with the 10th and the 11th Five-Year Plans, respectively.

⁵⁶ As brilliantly explained by Stacey Solomone, for China it is more important to show intentions than capabilities. "It is a sign of weakness to show one's capabilities, while using secrecy to hide them is a means to retain harmony and balance. Revealing capabilities would create an imbalance. This might seem counter-intuitive to a Western policy maker, but not from a Chinese perspective". For them, mutual dependence among actors in the global space community maintains balance. Because the Chinese clearly state their intention in the Space White Paper, then there is no need to reveal their hardware capabilities. Solomone, Stacey (2013). *China's Strategy in Space*. Springer, New York: p.59.

⁵⁷ McGregor, James (2010). "China's Drive for Indigenous Innovation. A Web of Industrial Policies". Global Regulatory Cooperation Project—US Chamber of Commerce. APCO Worldwide. A more detailed analysis of these guidelines is also provided in Sect. 4.3.

⁵⁸ For a detailed description of the 12th Five-Year Plan's policy processes, see Gilligan, Greg. "China's 12th Five-Year Plan. How it actually works and what's in store for the next five years". APCO worldwide. 10 December 2010.

⁵⁹ Government of the People's Republic of China. "China's Space Activities in 2011". White Papers of the Government of China. Beijing, China. 29 December 2011. Web. http://www.china.org.cn/government/whitepaper/node_7145648.htm.

Considering that the space programme was not previously subject to a national policy statement in its own right, the release of these documents merits attention, as it clearly signals both the increased relevance attached to space activities and the growing efforts made by Beijing policymakers in terms of making their space agenda more open to the scrutiny of the international community.

Like the previous versions, the most recent White Paper first highlights the most important achievements and breakthroughs realised by the national programme during the previous 5YP,⁶⁰ subsequently enunciates the plans and key priorities for the following years, and finally discusses the policy measures to undertake as well as China's international space-related policies.

2.3.1 China's Key Space Policy Targets

A specific feature of the latest space policy document is that it provides an unprecedented level of technical and operational information,⁶¹ demonstrating China's increased level of confidence and pride in the country's space capabilities. It has even been noted that in this regard, "the White Paper provides much more information than similar US documents on its space programme".⁶² Where the document is, however, much lacking compared to other national space strategies is—according to most analysts—in providing a clear picture of the underlying intentions regarding the pursuit of the space goals listed and the mechanisms through which policies will be implemented.

Although the statements might seem rather bland and the aspirations quite vague, the document is nonetheless far from a mere compendium of China's intended space activities for the next 5 years. By reading between the lines, a precise set of building blocks and priorities for the space policy comes into focus.

In designing its space policy, China has specified that the space programme "is subject to and serves the national overall development strategy and adheres to the principles of independent, peaceful, innovative, and open development".⁶³ In line with these four main principles, the principal axes for the development of space activities in China are identified as:

⁶⁰ In the case of the 2001 Space White Paper, the document describes the progress and achievements realised by China since 1956, thus filling an information gap regarding the development of the Chinese space programme during the previous 45 years. For a comparative analysis of the three White Papers, see Lele, Ajey, and Gunjan Singh (2012). "China's White Paper on Space: An Analysis". Institute for Defence Studies and Analyses Issue Brief.

⁶¹ See Pollpeter, Kevin (2012). "China's Space White Paper: Increasing Transparency...to a degree". China Brief Vol. 12: (3).

⁶² *Ibid.*

⁶³ Government of the People's Republic of China. "China's Space Activities in 2011". White Papers of the Government of China. Beijing, China. 29 December 2011. Web. http://www.china.org.cn/government/whitepaper/node_7145648.htm.

- Keeping the path of technological and operational self-reliance and independence in the development of the space programme/industry
- Adhering to the peaceful utilisation of outer space and opposing its *weaponisation* or any arms race in space
- Spurring the creation of a broader genuine innovation system through the implementation of space science and technology programmes
- Balancing independence and self-reliance with the adoption of an open and constructive attitude to international space cooperation on the basis of equality and mutual benefit

All these guiding principles eventually relate space activities to achieving the general objective of enhancing China's comprehensive national power (CNP): in short, space activities are intended as a tool designed to concurrently meet the demands of economic growth, scientific and technological development, national security, social progress, and increased international influence.

Beside these general principles, the documents provide a clear and comprehensive description of China's programmatic intentions for its space activities in the next 5 years. By combining the unprecedented level of operational technological details offered by the document with a reading of the long-term strategies and objectives identified by the CAS in its *Roadmap for Space Science and Technology*,⁶⁴ the specific targets of the current Chinese space policy 5YP can be spelled out and described in detail. These can be encapsulated in the five mission areas of space transportation, satellite development, orbital spaceflight, applications, and infrastructure building.

2.3.2 Space Transportation

In the area of space transportation, which is one of the largest budget items in the programme, China has clearly announced its intention to keep improving its launch vehicle series by enhancing the reliability and adaptability of the vehicles in service and developing a new generation of launchers in order to meet the country's future launch requirements. The *Chang Zheng* (Long March—LM) launch vehicle has so far been developed in four main configurations, of which three are still active: the LM-2, the LM-3, and the LM-4. Since 1970, these rockets have conducted 186 launches, of which 178 were successful.⁶⁵

In the next few years, China will continue to enhance launcher reliability and adaptability, while in the meantime focusing on the development of a new launcher

⁶⁴ Guo, Huadong, Ji Wu (eds) (2010). *Space Science and Technology in China: A Roadmap to 2050*. Chinese Academy of Sciences, Science Press (Springer), Beijing.

⁶⁵ See Harvey, Brian (2013). *China in Space. The Great Leap Forward*. Springer, New York, and the data provided by the annual compendiums of commercial space transportation of the Federal Aviation Administration (FAA).

fleet, using more efficient engines and an entirely new upper stage. The fleet will comprise three different configurations:

- The *Long March 5 (LM5)*, which will be the workhorse of the new fleet, is designed to be a heavy-lift launcher having a payload capacity of 25 tons to LEO and 14 tons to GEO. LM-5 has primarily been conceived for launching the large modules for the country's future space station, but up to six variants will be developed for different purposes.
- The *Long March 6 (LM6)*, described as a “high-speed launch vehicle”,⁶⁶ will be a light launcher, similar in appearance and capability to the European Vega, with a payload capacity of 1 ton to LEO. This launcher will “provide China an operational response capability for the first time, with obvious national security and commercial applications”.⁶⁷
- The *Long March 7 (LM7)*, a medium-lift launcher able to carry from 3 to 10 tons to LEO and from 1.6 to 6 tons to GEO.⁶⁸ The LM-7 will be developed from the LM-2 F and built with a variety of booster combinations in five different versions.

These new launch vehicles, as clearly set out in the White Paper, will be less toxic and more reliable than the ones currently in use. They will also be based on a “modular approach” in order to maximise commonalities and efficiency and, in parallel, provide a high level of adaptability to the diversity of launch requirements. The realisation of this programme clearly underscores China's readiness to attain comprehensive and flexible access to space matching, and competing with, that of the other major spacefaring nations. For instance, the LM-5D version, while primarily intended to launch large space station modules, has been identified by the Chinese as a potential rival to Ariane 5, “able to put two satellites into 24-h orbit simultaneously, compared to Ariane's one large and one medium”.⁶⁹ As for the LM6, it will also compete in the expanding market of lightweight satellites.

In addition, the 2011-released policy document for the first time officially announces China's intention to conduct pre-research on key technologies for a new super-heavy-lift launcher, dubbed by the media and analysts as Long March 9 (LM9). More information on this new launcher fleet, and in particular about the “Moon rockets”, will be provided in Sect. 4.3.

⁶⁶ Government of the People's Republic of China. “China's Space Activities in 2011”. White Papers of the Government of China. Beijing, China. 29 December 2011. Web. http://www.china.org.cn/government/whitepaper/node_7145648.htm.

⁶⁷ *Ibid.*

⁶⁸ More detailed information on the new launcher's fleet is provided in a number of analysis documents. See in particular Harvey, Brian. *China in Space. The Great Leap Forward*, Springer, New York, 2013: pp. 361–366.

⁶⁹ *Ibid.* p. 364.

2.3.3 *Satellite Development*

In the area of satellite development, the full spectrum of programmes is considered. The new policy calls for the development of an entirely new earth observation and navigation satellite series and for enhanced meteorological and communication satellites:

- *Earth Observation.* EO satellites are one of the most important lines of development of China's space programme, and more than forty EO satellites have been launched since 2001. In this field, China plans to continue the development of four main satellite series:
 - (a) The *ZiYuan* series for natural resources: this series was initially developed in collaboration with Brazil as CBERS⁷⁰ and five satellites had been launched as at 2012. One of the main purposes of the latest generation of this series (inaugurated in January 2012) is to obtain indigenous access to high-resolution geographical information and replace foreign commercial sources for imaging China.⁷¹
 - (b) The *HaiYang* series for oceanography and maritime observation: two generations of these satellites have been deployed, and the third is now under development. While the HY1 series (comprising 2 satellites) concentrated on ocean colour monitoring and the HY2 series (two satellites) used microwaves to monitor ocean dynamics, the third series includes three satellites that will be equipped with Synthetic Aperture Radar (SAR) for ocean surveillance and monitoring. In addition, in the field of EO oceanographic missions, China is planning a joint mission with France in 2015.⁷²
 - (c) The *HuanJing* series for environmental surveillance: these satellites are intended to form a constellation known as the Environmental Disaster Monitoring Constellation aimed at monitoring a variety of disasters, from

⁷⁰ China–Brazil Earth Resources Satellites (CBERS) is a joint China–Brazil programme in the field of earth observation developed under an agreement signed in July 1988. Three satellites were launched between 1999 and 2007. In November 2008, the two governments agreed to jointly continue the development of CBERS: CBERS-5 and CBERS-6 are expected to launch in 2017 and 2020, respectively.

⁷¹ Sensibly, China continues to rely on the Dragon programme with ESA for obtaining high-resolution geographical information of China. For more information on the Dragon programme, see “ESA–MOST Dragon Cooperation Programme”. European Space Agency, 21 August 2011. Web. <http://earth.esa.int/dragon/>. Accessed 19 February 2014. See also Desnos, Yves-Louis, and Li Zengyuan. “EO Science and Applications development in China”. In: *Dragon Programme Mid-term results*. Proceedings of the 2005 Dragon Symposium. European Space Agency, January 2006.

⁷² The French–Chinese Oceanic Satellite (CFOSAT) aims at monitoring wind and waves globally for the purpose of marine meteorology, ocean dynamics, climate variability, and surface processes. See Harvey, Brian (2013). *China in Space. The Great Leap Forward*. Springer, New York: p. 209.

floods and earthquake to forest fires and pollution. The constellation, to be launched by 2019, will comprise six optical and five radar satellites.⁷³

- (d) The *Yaogan* series for disaster management and surveillance: Yaogan are dual-use satellites utilised both for land survey, crop yield assessment, and disaster monitoring and for security-related observations.⁷⁴ Indeed, it is believed that their development is primarily aimed at providing China with a comprehensive military surveillance system combining optical, radar, and electronic intelligence (Elint). Nineteen Yaogan satellites were launched between 2006 and 2013, and improved versions can be expected to be developed and launched over the next few years.

Besides these four specific series, China has in addition expressed its intention to carry out development of a high-resolution all-weather, 24-h, multispectral EO system.⁷⁵

- *Communication Satellites*. The new guidelines, in addition to reiterating China's goal of developing enhanced communication satellites for fixed communication services as well as television, radio, and mobile communications, emphasise the country's interest in developing a new "satellite platform of higher capacity and higher power for the next generation of GEO communications and broadcasting satellites".⁷⁶ In effect, along with two more powerful variants of the *Dongfanhong-4* (*The East is Red, DFH-4*) satellite platform, China is now focusing on the development of the new DGH-5 platform.

While the DFH-4 was primarily developed for domestic missions and with the aim of reducing dependence on foreign technologies, the new platforms (the DFH-4S, the DFH-4E, and the DFH-5) are specifically intended to strengthen China's position in the global market of telecommunications platforms. China aims to seize 10 % of the international commercial satellite market by 2015, thanks to the development/export sales of the new DFH-4 variants. For its part, the DFH-5 will in the future help China gain an important share of the large spacecraft platform market, particularly thanks to its improvement in performance and reliability and its low cost compared to those offered by the United States, Russia, and Europe.⁷⁷

⁷³ Euroconsult (2013). *Government Space Markets—World Prospect to 2022*. Fourth Edition. A Euroconsult Research Report, Paris.

⁷⁴ *Yaogan* satellites specifically used for military reconnaissance are named *Jianbing*.

⁷⁵ Government of the People's Republic of China. "China's Space Activities in 2011". White Papers of the Government of China. Beijing, China. 29 December 2011. Web. http://www.china.org.cn/government/whitepaper/node_7145648.htm.

⁷⁶ *Ibid.*

⁷⁷ "Reaching for the stars: China's commercial space industry." Editorial: China Brain. Web. [http://www.china-brain.com/inner.php?eid=0082&goback=%2Egde_131398_member_2479741\\$32#13#.UvPYjfdUj4](http://www.china-brain.com/inner.php?eid=0082&goback=%2Egde_131398_member_2479741$32#13#.UvPYjfdUj4). Accessed 10 February 2014. See also "Chinese DFH-4 Platform Product Line Improvement." 2012. International Astronautical Federation. <http://www.iafastro.net/iac/archive/browse/IAC-12/B2/4/14084/>. Accessed 16 February 2014.

Not explicitly mentioned in the White Paper are the communications satellites for the PLA, in particular the *FengHuo* (“fire and smoke”⁷⁸) and *ShenTong* series, which started to be launched in the early 2000s. The precise performances are not known, but *ShenTong* is believed to provide Ku-band communication and *FengHuo* only C-band and UHF communication.⁷⁹ Further development in the field of military satellite communication systems can be anticipated.

- *Meteorological Satellites.* For a large country that is highly dependent on agriculture but often subject to damaging storms and floods, the development of reliable meteorological satellites has become a key priority, clearly reflected in the 2011 space policy. China has developed a meteorological satellite system, called *FengYun* (wind and cloud, FY), currently comprising two LEO and three GEO operational satellites.⁸⁰ A new generation of both LEO and GEO satellites (the FY-3 and FY-4, respectively) is now under development within the frame of the 12th Five-Year Guidelines (2011–2015) and is planned for launch around 2015. While the four LEO satellites of the FY-3 series that are yet to be launched will be equipped with instruments for 3D atmospheric detection,⁸¹ the FY-4 series will comprise four optical satellites and two microwave satellites to be launched by 2020.⁸²
- *Satellite Navigation.* In this field, Chinese policy reaffirms the “three-step” development plan followed for the development of its BeiDou/COMPASS Satellite Navigation System,⁸³ and it clearly emphasises China’s ultimate goal of providing a global satellite navigation capability. In accordance with the construction plan, the initial satellite navigation system has been enhanced and is now providing coverage in the Asia-Pacific region with positioning, navigation, timing, and short-message communication service capabilities. Since December 2012, the service has been made available to foreign customers, such as Pakistan. Needless to say, like the other navigation systems, BeiDou has also been designed to provide encrypted signals to the PLA. The system is

⁷⁸ The “fire and smoke” satellites are named after an ancient system of communicating utilising beacons along the Great Wall which were lit all along the wall in case of barbaric invasions. See Harvey, Brian (2013). *China in Space. The Great Leap Forward*. Springer, New York: p. 146.

⁷⁹ *Ibid.* p. 146.

⁸⁰ Euroconsult (2014). *Profiles of Government Space Programs, Analysis of Over 80 Countries & Agencies*. Euroconsult Profiles Series, Paris.

⁸¹ Three satellites of the FY-3 series have been launched so far, the last of which on 23 September 2013.

⁸² Euroconsult (2014). *Profiles of Government Space Programs, Analysis of Over 80 Countries & Agencies*. Euroconsult Profiles Series, Paris.

⁸³ The first phase of the programme, started in 1994 and completed in 2007, envisaged the creation of an experimental system. The second phase (2008–2012) was aimed at creating a regional system. The current and third phase (2013–2020) aims at building a global satellite navigation capability.

scheduled to complete the deployment of its 35 satellite constellation and to provide global coverage by around 2020.⁸⁴

- *Small and Microsatellites*. The development of small (less than 500 kg) and micro (less than 100 kg) satellites is not explicitly identified as one of the main targets for the 12th Five-Year Guidelines period (2011–2015), but advances are also expected in this domain. The main series of microsatellites that are currently in development are the China Seismo-Electromagnetic Satellites (CSES) and *Chuangxin* (literally “creation”) series. The CSES form a constellation of microsatellites aimed at detecting electromagnetic anomalies in the atmosphere and are part of China's earthquake monitoring network. Launches of these satellites are slated for 2014 and 2017 and will enable China to have an operational earthquake prediction system by 2020. As for the *Chuangxin* satellites, they are being developed by CAS in collaboration with the Shanghai Engineering Centre for Microsatellites and are designed to store and forward communications in case of disasters.

The above list of China's main targets in the field of satellite development is on its own impressive and is indicative of the confidence and importance China's leadership attaches to the development of the full spectrum of satellite capabilities. However, there is more.

2.3.4 *Space Exploration and Human Spaceflight*

In the area of space exploration and orbital spacecraft development, the White Paper identifies robotic lunar exploration and manned spaceflight as the two key priorities that will help boost the comprehensive development of space science in China. For the lunar exploration programme (CLEP), the document specifies once again the “three-step strategy” of orbiting, landing, and returning a sample and extends this model to other exploration missions. However, a new exploration mission to Mars (the *Yinghuo* programme) is not mentioned.⁸⁵

As for human spaceflight, the new policy reiterates China's ambition to develop all technologies necessary for enabling human spaceflight and for maintaining a permanent human presence in orbit. The construction of a space station appears the main longer-term goal envisaged in the document in regard to human spaceflight. An in-depth analysis of both the CLEP and manned spaceflight programme will be presented in the following chapter (Sect. 4.2).

⁸⁴ The constellation comprises 5 GEO satellites and 30 non-geo satellites. “BeiDou Navigation Satellite System”. Web. [http://www.beidou.gov.cn/2012/12/14/2012121481ba700d7ca84dfc9ab2\\$32#ab9ff33d2772.html](http://www.beidou.gov.cn/2012/12/14/2012121481ba700d7ca84dfc9ab2$32#ab9ff33d2772.html). Accessed 20 February 2014.

⁸⁵ Evans, Ben. “A Red Flag on the Red Planet: China's Mars Ambitions”. AmericaSpace. 15 October 2013. Web. <http://www.americaspace.com/?p=43535>. Accessed 15 March 2014.

Other relevant projects in the area of space science planned within the next 5 years include the following:

- *The KuaFu mission*, which represents one of the key missions within the broader Sun–Earth Connection (SEC) programme,⁸⁶ is specifically intended to establish a space weather forecasting system composed of a constellation of three satellites. One of these satellites will be placed at the Sun–Earth L1 Lagrangian point, with the other two in polar orbits. Initially slated to launch between 2012 and 2014, the mission has been postponed to the beginning of the 13th Five-Year Plan period (2016–2020).
- *The Space Solar Telescope (SST)*, another major programme initiated in 1992 by CAS, is aimed at studying the solar magnetic field, solar activities, and Sun–Earth interactions.⁸⁷ Its launch has not been scheduled yet.
- *The Black Holes Probe (BHP) programme*, which comprises a series of projects and experiments, is intended to study high-energy processes of cosmic objects and black hole physics.⁸⁸

2.3.5 Applications Development

The development of applications is specifically identified by the 2011 White Paper as the chief objective in the practical implementation of the Chinese space policy during the 12th Five-Year Guidelines period. The document consistently underlines the importance of exploring ways of making space profitable, by pushing the country’s emerging space capabilities to become industrialised, commercialised, and economically viable.

Three key areas are identified for the development and full utilisation (and commercialisation) of satellite-based applications and services, namely, earth observation, communications, and navigation. For each of these areas, the document envisages an extensive market-oriented provision of services.

This insistence on the development and commercialisation of the applications side of the satellite industry not only reflects the need to update and extend the industrial and commercial scope of China’s space industry; it also subtly discloses Beijing’s long-term ambitions to become a global provider of commercial satellite services alongside the provision commercial space launches.

⁸⁶ For more information on the SEC programme, see Guo, Huadong, Ji Wu (eds) (2010). *Space Science and Technology in China: A Roadmap to 2050*. Chinese Academy of Sciences, Science Press (Springer), Beijing: pp.64–65.

⁸⁷ *Ibid.*: pp. 59–64.

⁸⁸ The main missions of the BHP programme include Hard X-ray Modulation Telescope (HXMT) satellite, Space Variable Object Monitor (SVOM) satellite, and Gamma-ray Burst Polarisation (POLAR) experiment on board China’s spacelab. *Ibid.* p.60.

At the same time, this emphasis is indicative of the underlying intention to utilise space assets to meet the broader demands of national economic and social development targets identified in the 12th 5YP. In this regard, it should be noted that the Five-Year Plan in which the 2011 space policy is positioned has triggered a significant shift in the nation's economic growth model. Indeed, as emphasised by many analysts, the 12th 5YP is the first commercialisation-driven and pro-internal consumption plan in the macroeconomic planning of modern China.⁸⁹ The development of the satellite applications industry and the commercialisation of space-based services are thus particularly intended to support social and economic development targets.

2.3.6 Infrastructure Development

Lastly, the new Chinese space policy pays special attention to the need to develop an infrastructure for space activities that is capable of supporting the achievement of the aforementioned goals. Specifically, the policy document pledges concrete efforts to enhance the reliability and automation levels of the three existing launch sites and to proceed with the construction of a new launch site on the island of Hainan, southwest China. The new Wenchang cosmodrome, which is currently under construction and planned to be operational before the end of the 12th Five-Year Plan period (2015), is specifically designed to enable future manned and space exploration programmes. The new launch fleet, and the LM-5 in particular, will be launched exclusively from this site.

In terms of infrastructural development, attention is also given to the need to improve China's space TT&C network, to build Deep Space Network stations and to develop advanced TT&C technologies.

2.3.7 Policy Measures and International Cooperation

The list of goals China has set in its White Paper is as impressive as it is ambitious and underpins an increased level of confidence and pride in the country's space capabilities that was previously lacking. At the same time, the new Chinese space policy seems aware that the space industry might be taking on too many programmes and pursuing too many diverse objectives at the same time. In an attempt to prioritise goals, the White Paper specified that space applications take priority over space science and exploration in the implementation of the country's

⁸⁹ Roach, Stephen S (2011). "China's 12th Five-Year Plan: Strategy vs. Tactics". Morgan Stanley Asia. Web. http://www.law.yale.edu/documents/pdf/cbl/China_12th_Five_Year_Plan.pdf. Accessed 20 March 2014.

space policy. Yet the central government is directing the space industry to simultaneously develop a lot of space programmes in space sciences and exploration. As underlined by Stacey Solomone, while the government is guaranteeing a steady investment, with the mounting resources demand by the plethora of space programmes, the aerospace leadership will likely find difficulties in balancing national security needs, developing highly technical space programmes, and opening space to commercial use.⁹⁰ In addition to the programmes already underway, China's space policy—as noted above—has for the 2011–2015 period also planned a myriad of projects: it simply does not appear likely that China will be able to accomplish all these goals simultaneously, and delays—especially in terms of launcher development, human spaceflight and space science development—can thus be anticipated.

Doubtless aware of these potential pitfalls, the fourth section of the White Paper articulates a set of what it calls “development policies” designed to assist the realisation of the aforementioned programmes and objectives. Far from providing detailed mechanisms for the implementation of policies, these should rather be seen as a grand blueprint mapping out the overall strategy. What emerges is nonetheless a coherent and well-thought-out set of policy measures to effectively sustain the appropriate development of the space industry and its activities.

These measures envisage plans to promote a mutually beneficial interplay and integration between the space industry, academia, and the research community, which will gradually spur the creation of an ecosystem of innovation beneficial to space as well as to China's economy in general. In addition, they recommend a broad restructuring of the space-related industrial and R&D base, including the creation of new research facilities and engineering centres and, more importantly, the renewal of the country's skilled “social” capital relevant to space activities.

Interestingly, the document also highlights the fact that the emergence of new industrial capabilities is equally to be accompanied by steady and suitable financial investment and by a legislative framework creating a favourable environment for “the development of space entrepreneurship and market-oriented satellite utilisation schemes”.⁹¹ The adoption of a national space law is explicitly envisaged as a necessary step for creating a favourable environment for space activities.

Finally, a specific section is dedicated to the role of international cooperation, also regarded as an important policy measure, and intended as both a means to carry out the country's national objectives in space and to garner tangible recognition of its rising space status.⁹² Besides providing a very detailed account of China's principal bilateral and multilateral cooperation agreements signed up to 2011, the

⁹⁰ Solomone, Stacey (2013). *China's Strategy in Space*. Springer, New York: pp. 94–95.

⁹¹ Government of the People's Republic of China. “China's Space Activities in 2011”. White Papers of the Government of China. Beijing, China. 29 December 2011. Web. http://www.china.org.cn/government/whitepaper/node_7145648.htm.

⁹² Al-Ekabi, Cenán (2014). “European Space Activities in the Global Context”. In: Al-Ekabi, Cenán, Blandina Banares, Peter Hulsroj, Arne Lahcen (eds). *ESPI Yearbook on Space Policy 2011/2012. Space in Times of Financial Crisis*. Springer, Vienna: pp. 42–25.

policy document emphasises the requirements of a global space regime and gives the impression that the United Nations (UN) should have a major role to play in this regard. At the same time, it indirectly identifies regional cooperation as an important building block to consolidate global space governance and thus promises consistent advances within the frame of the China-led Asia-Pacific Space Cooperation Organisation (APSCO) (see Box 2.1).

Box 2.1: Asia-Pacific Space Cooperation Organisation

APSCO is a regional international organisation established in 2005 and operational since 2008. Currently, nine countries are signatories of the convention: Bangladesh, China, Indonesia, Iran, Mongolia, Pakistan, Peru, Thailand, and Turkey, while Kazakhstan, Malaysia, and Tajikistan are expected to accede to the Convention soon.

The main purpose of this intergovernmental organisation, set out in Article 4 of its Convention, is “to promote and strengthen the development of collaborative space programmes between Member States, to assist Member States, to promote cooperation, joint development, and to share achievements among the Member States”. The fields of cooperation identified by Article 6 of the Convention are space technology and applications, earth observation, space science research, education and training, space law, policy, and regulations. The implementation of a number of projects in each of these fields has already been initiated, together with a progressive consolidation of the institutional structure.

Within APSCO, China acts as a *primus inter pares*, providing the direction of the organisation and having very significant decision-making powers, while it also bears the major part of the financial cost. Overall, APSCO plays an important role in China's broader space diplomacy, which aims to provide the country with a leadership role in Asia and among developing countries.

Key cooperation areas for future space endeavours are identified by the document. Particular interest is shown in the field of space science, deep-space exploration (including the TT&C), and applications development, the last being the focal point of the ongoing 5YP for space activities.

Interestingly, the need for cooperative undertakings with regard to space debris monitoring and mitigation is also raised. The document clearly commits China to working together with the international community to maintain a peaceful and clean outer space, presumably both in terms of concrete joint undertakings and the elaboration of intergovernmental “best practices” and guidelines.

More importantly, the document also highlights the desire to engage extensively in international cooperation within the framework of China's human spaceflight programme, including technological and scientific cooperation for the future

Chinese Space Station (CSS). Since the publication of the White Paper, this plea has been increasingly reiterated by China's space officials. No occasion has been missed to underline the fact that China's space policy is open to the world. Indeed, China's commitment to cooperation has become the buzzword used by Chinese space officials in all the international fora with Chinese participation: for instance, the declarations released at the occasion of the International Astronautical Congress (IAC) meeting held in Beijing in September 2013 and at the International Space Exploration Forum (ISEF), held in Washington in January 2014, can be taken as consistent evidence of this approach.⁹³

⁹³ Lan, Chen; Jacqueline Myrrhe (eds). *Go Taikonauts. All about China's space programme*. Issue 10. December 2013. See also Lan, Chen, and Jacqueline Myrrhe (eds). *Go Taikonauts. All about China's space programme*. Issue 11. February 2014.



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