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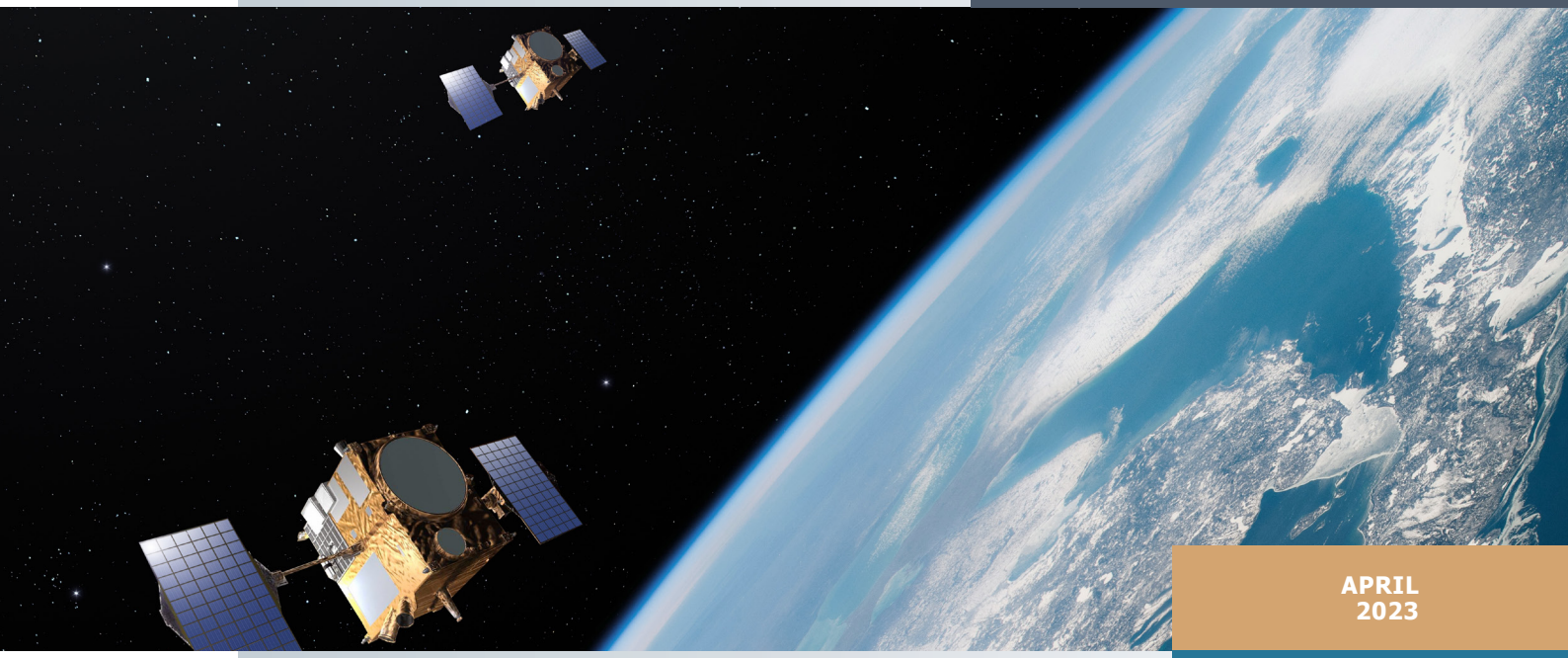

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China in the Race to Low Earth Orbit

Perspectives on the Future Internet Constellation *Guowang*

Marc JULIENNE

Center for Asian Studies and Geopolitics of Technology Program

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Abstract

In April 2021, the Chinese government officially, but rather quietly, established a new state-owned enterprise (SOE) named China SatNet. Its mission: build out China's "mega-constellation" program for low Earth orbiting internet satellites, known as Guowang ("national network"). Several scattered programs had already been launched in China since 2018, and the establishment of this new SOE appears aimed at streamlining and accelerating the development and deployment of the future national constellation.

China's goal is to position itself in the highly strategic sector that is space-based broadband mobile telecommunication networks, so far dominated by the American SpaceX and its Starlink constellation. These constellations promise significant commercial and military outcomes that have aroused the interest of states.

In this field, Beijing lags behind SpaceX, but demonstrates a fierce determination to catch up and compete with its rivals. China has already registered a request with the International Telecommunications Union to put 12,992 satellites into orbit, or roughly 1,000 more than what has so far been authorized for Starlink.

To achieve its goals, China relies on traditional aerospace and telecommunications SOEs, and now on the newcomer China SatNet. It also relies on an emerging ecosystem of companies and start-ups (GalaxySpace in particular), and encourages local governments to build production parks for the space industry and new launch centers across the country.

China is thus gearing up to achieve its ambitions, but will nevertheless have to face multiple challenges, including the financing of its industry in a constrained economic context, the development of a viable business model which has not yet been proven elsewhere, and above all, the growing strategic and technological rivalry with the United States.

Résumé

En avril 2021, le gouvernement chinois fonde officiellement, mais assez discrètement, une nouvelle entreprise d'État nommée China SatNet. Celle-ci a pour mission de porter le programme de « méga-constellation » de satellites internet en orbite basse, baptisée *Guowang* (« réseau national »). Plusieurs programmes épars existaient déjà en Chine depuis 2018, et la création de cette entreprise apparaît comme une volonté de rationaliser et d'accélérer le développement et le déploiement de la future constellation nationale.

L'objectif de la Chine est de se positionner sur un secteur éminemment stratégique qu'est celui des réseaux de télécommunication mobile haut débit basés dans l'espace, aujourd'hui dominé par l'Américain SpaceX et sa constellation *Starlink*. Ces constellations promettent des retombées commerciales et militaires importantes qui suscitent l'intérêt des États.

Dans ce domaine, Pékin accuse un retard certain sur SpaceX, mais démontre une détermination acharnée pour combler son retard et concurrencer ses rivaux. La Chine a d'ailleurs enregistré auprès de l'Union internationale des télécommunications une demande pour la mise en orbite de 12 992 satellites, soit environ 1 000 de plus que les autorisations actuelles accordées à *Starlink*.

Pour atteindre ses objectifs, la Chine s'appuie sur les acteurs étatiques traditionnels de l'aérospatial et des télécommunications, et désormais sur le nouvel entrant China SatNet. Elle s'appuie aussi sur un écosystème d'entreprises et de startups en pleine structuration (GalaxySpace notamment), et encourage les gouvernements locaux à construire des parcs de production pour l'industrie spatiale et de nouveaux centres de lancement à travers le territoire.

La Chine se donne ainsi les moyens d'atteindre ses ambitions, mais devra néanmoins faire face à de multiples défis, parmi lesquels le financement de son industrie dans un contexte économique contraint, la mise au point d'un modèle économique viable qui n'a pas encore été démontré à l'étranger, et surtout, la rivalité stratégique et technologique croissante avec les États-Unis.

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Introduction

Although it is still discreet and relatively inactive in Low Earth Orbit (LEO) internet constellations, China has taken a series of initiatives in recent years to make up for lost time, pursuing the clearly stated ambition of drawing level with the current dominant player in the sector, the U.S. firm SpaceX, and its Starlink constellation.

While many LEO internet constellation projects emerged during the years 2010 within China's state-owned industries and through new private players, the central government has now undertaken to streamline and centralize the efforts. In April 2021, it, therefore, founded a new state-owned firm called China SatNet to build the future *Guowang* "mega-constellation". The Chinese space industry is currently in the midst of a major effort to build an industrial complex capable of mass-producing future satellites and placing them in orbit.

This paper aims to gather and analyze open-source information with a view to understanding China's ambitions and policy orientations in the field of internet constellations, studying how this new industry is taking shape, and assessing the progress and potential of these projects.

As the sector is still emerging, the objective here is to provide some first insights into a field in which very little information and literature is available in English. Therefore, most of the sources used for this research are in Chinese.

First, we will discuss the stakes that LEO constellations represent for the major powers, particularly for the China-U.S. rivalry that is shaping contemporary international relations. Second, we will review the background and the political and industrial developments of the LEO internet constellation projects that have led to the creation of China SatNet and the structuring of China's new industrial space ecosystem. Finally, based on the analysis, we will outline the future prospects for the *Guowang* constellation in a tense geopolitical context.

LEO Constellations: A Strategic Aspect of China-U.S. Rivalry

Space-based internet is not a new idea but it has long proved to be less relevant than the available terrestrial solutions. So far, ADSL, fiber optics, and 3G, 4G, and 5G networks have offered performances (in terms of speed and latency) far superior to what space-based solutions could provide, and at a much more competitive cost.

Today, LEO "mega-constellation" projects can offer broadband connections and latencies comparable to land-based solutions, with the added advantage of being a global mobile network. In fact, this is the main advantage over terrestrial networks, as space-based internet covers white spots, deserts, forests, and oceans. However, one drawback remains, namely the cost. Although the cost of producing and launching satellites has definitely lowered in recent years, the price of user terminals and of subscribing to the service still prevents widespread use on a global scale.

The dominant player in the space-based internet sector is Elon Musk; his already operational Starlink constellation has a comfortable lead with about 3,500 satellites in orbit, of the 12,000 authorized, and a stated ambition to reach 42,000. In December 2022, Elon Musk's company, SpaceX, announced the launch of a new offer called Starshield, designed for government security agencies (observation and communication).[1] Today, Starlink's principal rival is OneWeb, a mainly European-Indian player, which completed its 618-satellite constellation in March 2023. For its part, Amazon plans to launch the first satellites of its Kuiper constellation in 2023, which will include 3,236 satellites in total. China, as we will see, is positioning itself on this market and could launch the first satellites of its future *Guowang* constellation in the coming months.

Beyond the commercial and technological competition between companies, "mega-constellations" in LEO are of major strategic importance for States for at least three reasons.

First of all, a mega-constellation implies applying for authorizations for thousands (or even tens of thousands) of orbital frequencies from the International Telecommunications Union (ITU). As frequencies are reserved on a "first come, first served" basis with the ITU, China must move fast to avoid other players, and primarily the Americans, monopolizing LEO.

1. See Starshield website: www.spacex.com

Second, these constellations offer military applications, brought to light by the war in Ukraine. Since the February 2022 attack by Russia, the Ukrainian armed forces have benefitted from a resilient telecommunications system thanks to Starlink. In addition to being dual-use systems, they have the added advantage of being highly redundant and therefore difficult to damage by kinetic means. Any nation equipped with these systems will thus have a decisive advantage over others that are not.

Finally, internet constellations primarily aim to provide a commercial mobile telecommunications service. Manufacturers are therefore expecting to reap economic benefits, even though the business model profitability is still to be demonstrated. The first entrant is therefore likely to capture the largest share of the market and to develop and perfect its offering ahead of its competitors. Commercial gains are not strategic for states *per se*, but they become strategic when providing a communications service helps to develop inter-state trade and to expand a nation's global outreach. China is already pursuing this ambition with the Digital Silk Road (DSR), which aims to develop digital infrastructure and services along the Belt and Road Initiative (BRI).[2]

For China, therefore, internet constellations are a key factor of power and influence in its rivalry with the United States. Seeing the progress of the U.S. pioneer SpaceX, China is seeking to carve out a position in the LEO constellation segment, both to reap the benefits of such a program, but also to avoid being left behind in the strategic competition with America.

2. D. Gordon, M. Nouwens (eds.), *The Digital Silk Road*, Adelphi, 2022.

Political-Industrial Development of a LEO Constellation Program in China

In December 2016, the "13th Five-Year Plan for National Informatization", issued by China's State Council, called for the construction of "integrated land, sea, air, and space information infrastructure" (陆海空天一体化信息基础设施).[3] With this aim, it particularly encouraged accelerating the deployment of space-based internet (空间互联网), relying on a satellite architecture in LEO. This objective ranks 6th (out of 74) among the priority "key tasks" listed at the end of the document. The Ministry of Industry and Information Technology (MIIT), the National Development and Reform Commission (NDRC), the Cyberspace Administration of China (CAC), and the State Administration of Science, Technology and Industry for National Defense (SASTIND) were jointly tasked with achieving it.

Also in 2016, a space component was added to the BRI, called the "BRI Space Information Corridor".[4] In November, NDRC and SASTIND published a document setting out the guidelines for the construction of this Corridor.[5] Although the document says little about internet constellations, it does state the intention to offer space-based services including communications, geolocation and remote sensing to the countries served by the Corridor. It mentions a "One Belt, One Road" broadband communication satellite network ("一带一路"宽带通信卫星网络). The Space Information Corridor continues to be mentioned in reference documents today (the 2021 Space White Paper for example), although much less so than the Digital Silk Road. The Tianjin Economic-Technological Development Area (TEDA) project nonetheless aims to launch pilot projects in the framework of the Corridor.[6]

3. "The State Council on issuing the '13th Five-Year Plan for National Informatization'" (国务院关于印发"十三五"国家信息化规划的通知), State Council, December 15, 2016, available at: www.gov.cn.
4. See L. Sénéchal-Perrouault, "Le couloir d'information spatiale des nouvelles routes de la soie : ambitions et réalités", Asia Centre, August 18, 2020, available at: https://asiacentre.eu.
5. "Guiding Opinion on Accelerating the Construction and Application of 'One Belt One Road' Space Information Corridor" (关于加快推进"一带一路"空间信息走廊建设与应用的指导意见), SASTIND and NDRC, November 23, 2016, available at: www.ndrc.gov.
6. "Implementation plan for comprehensive development of the start-up area of Science and Technology City" (科创城起步区综合开发实施方案), Tianjin Municipal People's Government, February 24, 2023, available at: www.tjbh.gov.cn.

The First Internet Constellation Programs

Between 2016 and 2018, various public and private internet constellation projects emerged, the main two being led by the two traditional state-owned space players in China: China Aerospace Science and Technology Corporation (CASC) and China Aerospace Science and Industry Corporation (CASIC).

CASC worked on the *Hongyan* constellation (鸿雁) whose goal announced in 2018 was to place 320 satellites in LEO by 2020. A first prototype satellite was launched in December 2018 but, since then, the project has stagnated. However, in December 2019, a new company – East is Red Satellite Mobile Communication Company (中国东方红卫星股份有限公司 or China Spacesat in English) – was founded by CASC, China Telecom, and China Electronic Corporation to oversee the *Hongyan* project.[7] At the time, they announced a first phase of the *Hongyan* project consisting of launching 60 satellites by 2022, thanks to a 20 billion yuan investment (€2.7 billion). The second phase was to be completed in 2025 with "several hundred" satellites in orbit. However, no satellite would appear to have been launched since the first prototype.

A parallel constellation project was developed by CASIC: *Hongyun* (虹云). This project was to have a total of 156 satellites by 2022, and the first prototype was also launched in December 2018. Again, no progress has been made since then. CASIC launched a second constellation project for the Internet of Things, named *Xingyun*, and two satellites were placed in orbit in May 2020 (on a Kuaizhou-1A launcher from Expace, a CASIC subsidiary). No other satellites have been launched since that date, despite a launch schedule of 80 satellites by 2023. The delay seems to be due to the failures of the Kuaizhou-11 launch vehicle, which finally completed its first successful flight on December 7, 2022.[8]

In April 2021, the CEO of China Spacesat or East is Red, Ge Yujun (葛玉君), told the Chinese press that the *Hongyan* and *Hongyun* projects would undergo "major changes" due to a re-evaluation of the planning of internet constellations by central government.[9]

The government's interest in LEO internet constellations has not, however, been denied, quite the contrary. In 2020, with initiatives being taken in all directions and without any coordination, the authorities seem to have realized the need to streamline and centralize the efforts. This, in fact, is quite a usual method in China: the authorities open up an industrial sector

7. "Many Central Companies Join Forces: National Commercial Aerospace Project 'Hongyan Constellation' Put into Operation" (多家央企联手国 家级商业航天项目"鸿雁星座"投入运营), SASAC, December 23, 2019, available at: www.sasac.gov.cn.
8. "New Rocket Successfully Takes to Outer Space", *China Daily*, December 7, 2022, available at: www.chinadaily.com.cn.
9. "China Satellite: Relevant national departments are coordinating the planning of constellation plans including Hongyan and Hongyun" (中国卫星：国家相关部门正统筹规划鸿雁、虹云在内的星座计划), Sina, April 19, 2021, available at: https://finance.sina.cn.

and encourage public and private players to enter it without any restrictions, in order to attract companies and financing; they then introduce regulations (often suddenly) in order to organize the market. This approach was already seen in the solar panel industry in the early 2010s and in the bike-sharing market in 2017.

For the first time in April 2020, NDRC identified space-based internet as one of the priorities of "new infrastructure" (新型基础设施) for innovation.[10] This "new infrastructure", including in space, is also mentioned in the "14th Five-Year Plan" of the People's Republic of China (PRC) released in March 2021[11]. Space infrastructure also features extensively in the "14th Five-Year Plan for National Informatization"[12]. Furthermore, the 16th China Science and Technology Hall Forum in August 2022 was dedicated to "Satellite Internet - Safeguarding China's Security" ("卫星互联网-守护平安中国")[13].

Through this "new infrastructure", China clearly states the ambition to build an "integrated space-land information system" (天地一体化信息系统),[14] aimed at making land-based (fiber optics, 5G radio waves) and space-based (broadband constellation and eventually quantum communication satellites) communication networks interoperable.[15]

Above all, in September 2020, the Chinese government filed an application for frequency registration with the ITU, for two broadband constellations totaling 12,992 satellites, on behalf of the Chinese company China Telecom Satellite Communications. The first constellation is named GW-A59 (GW being the initials of *Guowang* 国网 or "national network"). It has 6,080 satellites.[16] The second, GW-2, will comprise 6,912 satellites.[17] The two *Guowang* constellations therefore exceed the current authorizations granted to Starlink by around a thousand satellites.

It is worth noting that under the ITU Radio Regulations, after registering its application, a State has seven years to place at least one satellite in orbit. After this initial period, it then has two more years to place 10% of the planned constellation in orbit, five years to complete 50% of the

10. "The National Development and Reform Commission clarifies the scope of "new infrastructure" for the first time" (国家发改委首次明确"新基建"范围), Ministry of Commerce of the PRC, April 21, 2020, available at: www.mofcom.gov.cn.
11. "The 14th Five-Year Plan for the National Economic and Social Development of the People's Republic of China and Outline of Long-term Goals for 2035" (中华人民共和国国民经济和社会发展第十四个五年规划和 2035 年远景目标纲要), Chinese Central Government, March 12, 2021, available at: www.gov.cn.
12. "14th Five-Year Plan for National Informatization" ("十四五"国家信息化规), Chinese Central Government, December 2021, available at: www.gov.cn.
13. "The 16th China Science and Technology Hall Forum focused on "Satellite Internet"" (第十六期中国科技会堂论坛聚焦"卫星互联网"), China Association for Science and Technology, August 28, 2022, available at: https://baijiahao.baidu.com.
14. ""New infrastructure", White Paper on China Satellite Internet Industry Development (《"新基建"之中国卫星互联网产业发展研究白皮书》), CCID Consulting – IoT Industry Research Center (赛迪顾问物联网产业研究中心), May 27, 2020.
15. See M. Julienne, "Le rêve quantique chinois : les aspirations d'un géant dans l'infiniment petit", *Études de l'Ifri*, February 2022.
16. See the ITU website: www.itu.int.
17. *Ibid.*

constellation, and seven years to complete it entirely. If it fails to meet these deadlines, the number of authorized satellites is reduced in proportion to the number of satellites placed in orbit. Therefore, Beijing must put at least one satellite in orbit by 2027, 10% or 1,299 satellites by 2029, 50% or 6,496 satellites by 2032, and all 12,992 satellites by 2034. These goals are achievable if China is able to launch about 200 satellites per year, starting in 2023 and continuing through 2029.

Finally, in May 2021, the State-owned Assets Supervision and Administration Commission (SASAC) announced the creation of a new state-owned company dedicated to internet constellations: China SatNet. This last step appears to mark a change of approach by the Chinese authorities in the race to LEO.

China Satnet: A State-Owned Giant in the Making

China Satellite Network Group Co., Ltd or China SatNet (中国卫星网络集团有限公司) was founded on April 28, 2021, with a capital of RMB 10 billion (€1.3 billion). It is a public company wholly owned by SASAC. Its mission is to support the LEO internet constellation program and therefore to build the two *Guowang* constellations. China SatNet is therefore responsible for the "design, construction and operation of the satellites"(卫星互联网设计建设运营).[18] In view of its stated missions, the apparent freeze placed on the previously launched *Hongyan* and *Hongyun* projects, and the diversity of profiles recruited in the management team (see below), China SatNet has no doubt eclipsed all the other state projects and aims to reap all the efforts, budgets, and talent.

Other sources suggest that China SatNet is primarily tasked with providing the satellite service, with satellite production and launch being outsourced to aerospace companies[19]. The Second Academy of CASIC, for example, seems well positioned. It claims to have developed the country's first intelligent production line capable of mass-producing small satellites in Wuhan[20]. In March 2023, it announced that it was preparing a constellation in very low Earth orbit (less than 300km altitude), with a first launch scheduled for September 2023. This constellation would apparently be used

18. Job offer available at China SatNet: http://job.neu.edu.cn.
19. Shi Aiping (史爱苹) "The new State enterprise China SatNet" (新央企中国卫星), *Modern SOE Research* (现代国企研究), June 2021.
20. In 2021, CASIC mentioned the figure of 240 satellites per year, but this estimate was not mentioned again in 2022. "China's first batch-production satellite intelligent production line is in trial operation, with an annual output of more than 240 small satellites" (我国首条批产卫星智能生产线试运行，可年产240 颗以上小卫星), *The Paper* (澎湃), January 19, 2021, available at: https://m.thepaper.cn; "China's First Small Satellite Intelligent Production Line, Ultra-Low Orbit Satellite..." (我国首条小卫星智能生产线、超低轨卫星……), *Wuhan Science & Technology Journal* (武汉科技报), November 8, 2022, available at: https://rmh.pdnews.cn.

for imaging and telecommunications, although no details have been made public, including the number of satellites the constellation would comprise.[21]

Since it was founded, China SatNet has been a rather mysterious company and very little information about it is available. For example, the group does not have a website and communicates very little, be it on its organization or its objectives and progress. This seems rather inconsistent with the ambition of the project, i.e., compete with or offer an alternative to Starlink, and the relatively tight schedule (the end of the 2020s) for achieving it. The discretion surrounding China SatNet's activities could be explained by the company's lack of maturity and organization, and perhaps by certain uncertainties regarding its technical, technological and strategic directions.

An analysis of the profiles sitting on China SatNet's Board of Directors reflects the company's specificity and its *raison d'être*, at the intersection between aerospace, telecommunications and electronics. The company's Chairman and Communist Party secretary, Zhang Dongchen, is a telecommunications engineer who has spent most of his career at China Electronics Technology Group (CETC), China's largest state-owned defense electronics conglomerate. The CEO and Party vice-secretary is Yang Baohua, an aerospace engineer from CASC, where he had been Vice-President since 2014.[22]

China SatNet Board of Directors (source: *aiqicha*)	
ZHANG Dongchen 张冬辰	Telecommunications engineer who has spent most of his career at China Electronics Technology Group (CETC)
YANG Baohua 杨保华	Aerospace engineer from CASC, where he had been Vice-President since 2014.
LI Yuhai 李玉海	Aeronautical engineer, previously Vice-President and Party deputy secretary of the state-owned defense group AVIC where he has spent his entire career (particularly within the subsidiary Shenyang Aircraft Design Institute). Since 2020, he has also been an external member of the Board of Directors of CASC.
LIU Xing 刘星	After training in the United States in computer and telecommunications engineering, he has worked in the fintech sector in the United States and Asia.

21. "China to build Constellation of Very-Low Earth Orbit Satellites", *Global Times*, March 2, 2023, available at: www.globaltimes.cn.
22. "The Whole Leadership of this New Communication Company (Xingwang) Has at Least a Master's Degree, and Half of the Team Holds a PhD!" (太牛了！这家通信新央企（星网）领导班子学历最低是硕士，一半是博士！), 运营商段子手, March 13, 2021, available at: www.163.com.

SHANG Bing 尚冰	Chemical engineer (polymers) who trained in Shenyang and at New York University. He sat on the executive committee of China Unicom, and then China Telecom. He was then Vice-Minister of the MIIT (from 2011) and simultaneously deputy director of Cyberspace Administration of China in 2015, then President and Party secretary of China Mobile Group (2015-2019). Since 2020, he has been an external member of the Board of State Grid Corporation of China, and President of the Internet Society of China.
BI Xianghui 毕向辉	Director of Financial Assets of China SatNet. Previously deputy director of the Finance Department of China Electronic Corporation (CEC).[23]
LI Xiaochun 李晓春	Electronics engineer, former senior executive of CASIC and China General Technology (Genertec). He is now a member of the Board of Directors of China SatNet and a member of the management of Chongqing Aerospace Measurement Communication Technology Co., Ltd. (重庆航天测量通信技术有限责任公司).
DUAN Hongyi 段洪义	Electrical engineer, who has spent most of his career at Harbin Electric Group Corporation and then at Nam Kwong (SOE based in Macau)[24]. Since 2020, he has been an external Board member of China Telecom and China National Nuclear Corp. (CNNC)

China SatNet has several subsidiaries dotted across the country, the number and names of which have changed somewhat since 2021. There are currently eight main subsidiaries.

23. See the biography of Bi Xianghui: http://mingziji.com.

24. See the Nam Kwong Group Limited website: http://en.namkwong.com.mo/.

List of China SatNet Subsidiaries
China Star Network, Network Application Research Institute Co., Ltd. 中国星网网络应用研究院有限公司
China Star Network, Network Innovation Research Institute Co., Ltd. (Beijing) 中国星网网络创新研究院有限公司（京）
China Star Network Sharing Service Co., Ltd. 中国星网共享服务有限公司
China Star Network, Network System Research Institute Co., Ltd. (Beijing) 中国星网网络系统研究院有限公司
China Star Network, Network Application Co., Ltd. (Beijing) 中国星网网络应用有限公司（京）
Shanghai Satellite Internet Research Institute Co., Ltd. 上海卫星互联网研究院有限公司（沪）
Micronite Communication Technology (Beijing) Co., Ltd. 迈科奈特通信科技(北京)有限公司
Chongqing Star Network, Network System Research Institute Co., Ltd. 重庆星网网络系统研究院有限公司

China SatNet will have a brand new headquarters building in a new industrial zone called "Xiongan New Area" (雄安新区), in Hebei province, 100 kilometers south of Beijing. A groundbreaking ceremony was held at the site for the founding of the company, attended by Han Zheng, then a member of the Standing Committee of the CCP Political Bureau and Senior Vice-Premier.

Similar to what Shenzhen was for Deng Xiaoping in the early 1980s, the "Xiongan New Area" is a modernization project initiated by Xi Jinping himself. However, the notable difference is that Shenzhen was a laboratory for capitalism, whereas Xiongan is emerging as the implementation of the centralized and ideological vision of technological innovation at the Party's service. Initiated in 2015, the project aims to relieve the pressure on the capital and embody the smart, green city of the future, an innovation center for Chinese tech. However, it is facing difficulties in terms of attractiveness and financing and is falling behind schedule.[25] [26]

25. "Xi Jinping Visits Xiongan New Area in Show of Impatience at Lack of Progress on 'Future City' Plan", *South China Morning Post*, January 27, 2019, available at: www.scmp.com; D. Macklin, "Xiongan New Area, 5 Years on", *The Diplomat*, April 1, 2022, available at: https://thediplomat.com.
26. "The Construction of the Xiongan Headquarters Building of China Star Network is Progressing Steadily" (中国星网雄安总部大楼建设稳步推进), *Beiqing Wang* (北青网), September 7, 2022, available at: https://baijiahao.baidu.com; "From the landing of China Satellite Network Group to see how Xiong'an New District can Do a Good Job in Undertaking and Dispersing Work" (从中国卫星网络集团落地看雄安新区如何做好承接疏解工作), *People's Information* (人民资讯), August 18, 2022, available at: https://baijiahao.baidu.com.

Galaxyspace: The Private Outsider

The private startup GalaxySpace (银河航天), founded in 2016, also has ambitions to develop a broadband internet constellation. It launched its first experimental satellite in October 2018, and its first 5G satellite in January 2020, the Yinhe-1, carried by a Kuaizhou-1A launcher (Expace)[27].

In 2020, GalaxySpace built a "super factory" in Nantong (Jiangsu) for the mass production of satellites, and the company has announced a future production capacity of 300 to 500 satellites per year.[28]

Since 2022, GalaxySpace claims to have placed the first Chinese broadband internet constellation in orbit. Going by the name "Mini-spider Constellation", it consists of six experimental satellites, which were placed in orbit on March 7, 2022 by an LM-2C launch vehicle fired from the Xichang spaceport. The six satellites (called GS-2, GS-AP01, GS-AP02, GS-AP03, GS-2BP01 et GS-2BP02) are smaller (190 kg) and more efficient than Yinhe-1.

GalaxySpace has already applied to the ITU for new frequency registrations for nine satellites called GQ-3A[29] and nine others called GS-3B.[30]

Boom in the Chinese Space Industry

Satellite Production

One indicator of the boom in Chinese satellite production over the past two years is the emergence of dedicated industrial parks throughout the country, supported by local funding.

In May 2021, SASTIND and the Equipment Development Department of the Central Military Commission issued the "Notice on Promoting Orderly Development of Microsatellites and Strengthening Safety Management".[31] The goal was to encourage, but also to provide a framework for the satellite industry, which has seen a growing number of private players emerge since the market opening and government incentives of 2014.[32]

Shanghai municipality, which is already a historic center of the space industry, issued an "opinion" in February 2022 on promoting the space

27. "GalaxySpace's Xu Ming: China's Opportunities for Internet Satellite" (银河航天徐鸣：卫星互联网的中国机遇), *TMTPost*, August 10, 2020, available at: http://www.yinhe.ht.
28. A. Jones, "China Launches Test Satellites for Broadband Constellation", *Space News*, March 7, 2022, available at: https://spacenews.com.
29. See the ITU website: www.itu.int.
30. *Ibid.*
31. "Notice on Promoting the Orderly Development of Microsatellites and Strengthening Safety Management" (关于促进微小卫星有序发展和加强安全管理的通知), SASTIND, May 19, 2021, available at: www.sastind.gov.cn.
32. M. Julienne, "China's Ambitions in Space: The Sky's the Limit", *Études de l'Ifri*, January 2021, pp. 21-26.

industry in the city.[33] In this opinion, it intends to include Shanghai in the space objectives defined by the 14th Five-Year Plan and especially to strengthen its position in space-based internet.

In Wuhan (Hubei province), the "Wuhan National Aerospace Industry Base" has been created in Xinzhou district on the bank of the Yangtze River. Led by CASIC, it specializes in the production of launch systems (Kuaizhou)[34], and satellites. The base has been officially operational since November 2021, with an annual production capacity of 20 launchers and 100 small satellites[35]. It is now presented as the "3rd pole" of the Chinese space industry (after Beijing and Shanghai by deduction) and as the future "China Star Valley" (中国星谷).[36]

In Guangzhou, the automotive manufacturer Geely is the main player in the "Nansha Aerospace Science and Technology Industrialization Base" (南沙航天科技产业化基地), a satellite development and production park. Geely (which owns Volvo) is working on a constellation of LEO satellites for its autonomous cars. Nine test satellites were placed in orbit as part of this program in June 2022 (via an LM-2C launcher).[37] The Nansha industrial base is home to Geely's space subsidiaries: Shikong Tansuo, Geespace, Shanghe Aerospace, Xingkong Zhilian, and SpaceOK.

The spin-off of the Chinese Academy of Sciences, CAS Space Exploration (or Beijing Zhongke Aerospace Exploration Technology Co., Ltd.), which specializes in launches, is also present in Nansha with the aim of this company eventually launching Geely's satellites.[38]

Shenzhen metropolis, near Guangzhou, also entered the space industry in June 2021, but mainly in the downstream segment, [39] with the "Global Commercial Remote Sensing Satellite Station Network Headquarters Base" (全球商业遥感卫星站网总部基地).

Chongqing, a megalopolis in the center of China, also began positioning itself in the space industry in 2018. Chongqing is where East is Red Satellite

33. "Implementation Opinions on Promoting the High-Quality Development of the Spatial Information Industry in this City" (关于本市推进空间信息产业高质量发展的实施意见), Government of the Shanghai Municipality, February 16, 2022, available at: www.shanghai.gov.cn.
34. "China's CASIC Reveals Five-Year Plan for Reusable Spaceplane, Commercial Space Projects", *Space News*, October 19, 2020, available at: https://spacenews.com.
35. "Rocket Industrial Park Put into Operation in Wuhan", *China Daily*, November 26, 2021, available at: https://global.chinadaily.com; "Wuhan National Aerospace Industry Base Satellite Industrial Park will Achieve an Annual Production Capacity of 100 Satellites" (武汉国家航天产业基地卫星产业园将实现百颗卫星年产能力), *Xinhua*, March 4, 2021, available at: www.gov.cn.
36. "The Scale of the Aerospace Industry to Reach 100 Billion, Wuhan to Make Efforts to Build "China's Third Pole of Space"", (航天产业规模要达千亿级，武汉发力建设"中国航天第三极"), Hangtian Xingyun Technology Limited Co., March 17, 2022, available at: https://mp.weixin.qq.com.
37. A. Jones, "Long March 2C Launches 9 Navigation Test Satellites for Chinese Automaker", *Space News*, June 2, 2022, available at: https://spacenews.com.
38. "Shenzhen Offers Support to Boost Satellite Sector in Chinese City", *Space News*, June 9, 2021, available at: https://spacenews.com.
39. "Work Opinions of Shenzhen on Supporting the Development of Satellite and Application Industries" (深圳市关于支持卫星及应用产业发展的工作意见), Development and Reform Commission of Shenzhen Municipality, June 7, 2021, available at: http://fgw.sz.gov; "Boost Shenzhen to Form a Complete Commercial Aerospace Industry Chain. The Headquarters Base of The Global Commercial Remote Sensing Satellite Station Network Settled in Dapeng" (助推深圳形成完整商业航天产业链 全球商业遥感卫星站网总部基地落户大鹏), *Sohu*, August 10, 2022, available at: www.sohu.com.

Mobile Communication Co., the company founded in late 2019 for the *Hongyan* project, is based, along with the startup One Space, which develops launchers.[40]

New Launch Centers

The momentum is also spreading to the field of launches, where developments are going full blast. After the 2016 opening of a fourth space launch center in Wenchang on Hainan Island in the South China Sea, Beijing has announced the construction of three other launch sites on the coast, dedicated to commercial activities.

The first is a floating launch pad off the coast of Haiyang in Shandong Province. It hosted its first operational launch on December 9, 2022, with the Jielong-3 launch vehicle (its very first launch), carrying 14 satellites into sun-synchronous orbit.[41]

The second site will be built in Xiangshan near the Ningbo metropolis in Zhejiang province. An industrial park for satellite development and construction will also be established near the launch center, called "Xiangshan's Ningbo Aerospace Science and Technology Town".[42]

The third center is in Wenchang, near the current LM-5 and LM-7 launch site. The goal announced is to develop the "Wenchang International Space City" by attracting commercial and international launches. This site should also play a central role for *Guowang*.

However, the exhilaration in the Chinese space industry should be qualified. Construction of these three new sites will require a large number of experienced personnel within a short timeframe, but these profiles are limited in number, and onboarding new young talent implies an incompressible training period. These projects also demand substantial budgets in an increasingly constrained economic context. In addition, the new centers are supposed to meet demand for launches that is expected to grow substantially in the years and decades to come, but a great deal of uncertainty remains in the launch market. Lastly, according to Chinese expert Huang Zhicheng, to meet growing national institutional demand in the coming years (*Guowang* constellation in particular), heavy launchers, such as the LM-5 fired from Wenchang, will be able to carry many more satellites than the small launch vehicles fired from these new sites. Huang, therefore, questions the relevance and economic viability of these new spaceports.[43]

40. "Two Key Aerospace Industry Projects Started Construction in Chongqing Liangjiang New Area" (两个航空航天产业重点项目在重庆两江新区开工), *Chongqing Morning Post* (重庆晨报), December 17, 2020, available at: http://cq.china.com.cn.
41. A. Jones, "China Launches 14 Satellites with New Solid Rocket From Mobile Sea Platform", *Space News*, December 9, 2022, available at: https://spacenews.com.
42. A. Jones, "Ningbo, Wenchang to Construct Chinese Commercial Spaceports", *Space News*, April 8, 2021, available at: https://spacenews.com.
43. J. Ma, "Experts Call for Caution as Zhejiang Plans $3b Space Launch Center", *Global Times*, April 7, 2021, available at: www.globaltimes.cn.

Ground Segment: The Key Challenge of Terminals

Despite being significantly behind Starlink and OneWeb, China could nonetheless become competitive quite quickly, not in terms of the number of satellites in orbit, but *via* a low-cost user terminal and subscription offer which would be more affordable for populations and companies worldwide. Beijing could then establish itself as a serious competitor, by demonstrating the viability of its economic model.[44] There are two ways in which China could reduce the selling price: either through an innovative industrial process, or through public subsidies that would drive prices down.

It is not known which public or private company will be tasked with developing and producing the *Guowang* user terminal, but Huawei, ZTE, and CETC seem to be plausible candidates given their expertise.

44. Interview with ITU, December 13, 2022.

Geopolitical Divide: Toward a Technological World Partition?

The strategic rivalry between China and the US is taking place above all in the field of technology, due to the potential for military operations, trade, and influence.

Beijing is above all counting on technological innovation to close the gap with and attempt to overtake the United States by mid-century. Meanwhile, Washington is well aware of China's determination and ramp-up, which it sees as an existential threat.

The first wake-up call for the United States was the success of Chinese manufacturers Huawei and ZTE in supplying 5G infrastructure around the world as of 2018. For the first time, the Americans were overtaken and were even missing from this sector. Only the European players Nokia and Ericsson offered an alternative to China. The absence of American firms from this strategic sector and China's lead were a traumatic experience and an alarm bell for Washington.

The American Response

The Trump administration soon took very strong, targeted action against Huawei, ZTE, and their subsidiaries. In 2019, for reasons of national security, Washington began by banning the Chinese manufacturers from the American 5G market, before banning the export and re-export of U.S. components and intellectual property to these companies, and finally closing the American market to all equipment and services supplied by them (including the sale of phones, for example).

These obstructionist measures did not stop solely at U.S. territory. Washington also endeavored to convince as many partners and allies as possible to close their 5G markets to Chinese manufacturers too. The Department of State thus launched the "Clean Network" initiative, aimed at protecting its members "from aggressive intrusions by malign actors, such as the Chinese Communist Party".[45]

The second area of action was semiconductors. In 2020, Donald Trump used export controls to limit the transfer of high-end semiconductors to Huawei and other companies. When Joe Biden took up office in 2021, this approach was not called into question and, on the contrary, the new

45. "The Clean Network", U.S. Department of State website, available at: https://state.gov.

administration has further pursued these measures to hinder the Chinese innovation ecosystem.

In a speech given in September 2022, Jake Sullivan, National Security Advisor to the President of the United States, announced that the United States' goal was no longer to "stay only a couple of generations ahead" of its competitors, but rather to "maintain as large of a lead as possible".[46] The following month, the United States introduced new export controls on high-end semiconductors. This time, it was not targeting individual companies, but the People's Republic of China as a whole. All companies worldwide are prohibited from exporting U.S. components or intellectual property related to certain semiconductors to China. In addition, in January 2023, the United States succeeded in convincing the Netherlands and Japan not to export certain semiconductor production machinery to China.

This American strategy also affects the space sector and could have an impact on the future of Chinese constellations for two reasons. First, the obstacles to the procurement of the latest-generation semiconductors could have direct or indirect consequences on the Chinese space industry. These microprocessors are not only used in satellites but also in user terminals. They are also essential for the supercomputers used in aerospace engineering. The United States will then replicate the method applied for 5G and semiconductors, in the space sector, as it already has done in the fields of biotechnology and quantum technology.

Washington is already taking steps in the field of LEO constellations. In January 2023, the Federal Communications Commission (FDD) reorganized its International Bureau into a Space Bureau and an Office of International Affairs.[47] As the limited number of orbital frequencies is the sinews of war, the priority is to reserve these frequencies as soon as possible, ahead of private or institutional competitors. Before applying for a frequency authorization from the ITU, the satellite must first be granted a license by the national regulator, the FDD in the United States. The FDD Space Bureau has been established with the aim of liberalizing and accelerating the licensing of LEO satellites produced by U.S. companies, in order to adjust to a rapidly changing space industry and a highly competitive international environment.[48]

A recent U.S. report released by the CSIS, funded by Amazon Kuiper and SpaceX, accurately describes this phenomenon: "regulators also need to consider emerging and conflicting interests between U.S. firms and foreign competitors and between market incumbents and entrants". The report goes

46. "Remarks by National Security Advisor Jake Sullivan at the Special Competitive Studies Project Global Emerging Technologies Summit", White House, September 16, 2022, available at: www.whitehouse.gov.
47 . "Establishment of the Space Bureau and Office of International Affairs", Federal Communications Commission, January 9, 2023, available at: www.fcc.gov.
48. "Chairwoman Rosenworcel Announces Plan to Modernize the FCC by Establishing a Space Bureau and Office of International Affairs", FCC, November 3, 2022, available at: www.fcc.gov.

on to say: "One of the largest bottlenecks to market dominance in LEO broadband is licensing".[49]

As in other technological fields, the U.S. objective is therefore to maintain its "space dominance". And China is seen as the main threat, both in terms of national security and the market.[50]

Market Partitioning

In terms of market opportunities, political rivalry will play a major role. China should see its access to certain markets closed or restricted, especially in liberal democracies such as the United States, Canada, Japan, Australia, and Europe, where the Chinese internet will raise questions of security, but also of freedom and censorship.

Conversely, China will seek to reserve certain markets, in countries hostile to the West and promoting an authoritarian and controlled approach to internet: its national territory, Russia, Belarus, and the powers under Chinese influence in Central Asia, Pakistan, Cambodia, Laos, and Myanmar, as well as Iran, certain African countries (Zimbabwe, Eritrea, Egypt) and South America (Venezuela).

In the rest of the global South, the "narrative" of the BRI and the "Digital Silk Road" could serve as a vector of influence to prepare for the arrival of *Guowang* in these countries.

However, in the case of space-based internet, this geopolitical analysis of global technological partitioning must also take into account the relevance of such a space service for the countries concerned, as well as its cost. In the global South, where internet coverage is poor in many regions, LEO constellations make sense, but the cost of the service would seem prohibitive as it stands today.

The opportunities for China, therefore, appear limited and uncertain for the time being, especially if the market sees the emergence of new alternative players to the United States and China, such as Europeans.

49. M. Young, A. Thadani, *Low Orbit, High Stakes, All-In on the LEO Broadband Competition*, CSIS, December 2022, p. 16.
50. *Ibid*. p. 14.

Conclusion

The determination of the Chinese authorities seems limitless, and the industry is preparing to achieve the ambition of rivaling with the United States and becoming a major player in space-based broadband internet.

This determination could allow China to launch a great many satellites within a short timeframe. However, there is still a long way to go and the gap with Starlink and OneWeb is wide, especially in a sector which has yet to prove that it has viable commercial opportunities to offer.

One of the main difficulties in estimating China's future capabilities for its *Guowang* project (which has been facing delays since 2018) lies in assessing the impact of the Covid-19 pandemic on the space industry. While the health crisis has indeed caused major disruption, China can be expected to resume development at a steady pace now that it has lifted the zero-Covid policy. However, with rampant totalitarianism in China, repressive campaigns against the tech sector, and the constant injunction to innovate, the conditions are not optimal for the development of science and technology. In addition, many indicators point to difficult years ahead for the Chinese economy, and therefore possibly for space industry funding.

Finally, the geopolitical context is a decisive factor in assessing the potential technical and commercial success of the future *Guowang* constellation. The strategic rivalry between Beijing and Washington, and the growing desire for technological decoupling, could close many markets to China, but could also reserve some others for it.

Therefore, to complete its *Guowang* constellation, not only must China overcome obstacles in terms of technology, finance, and commercial viability, it will also face an uncompromising confrontation with the United States.

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