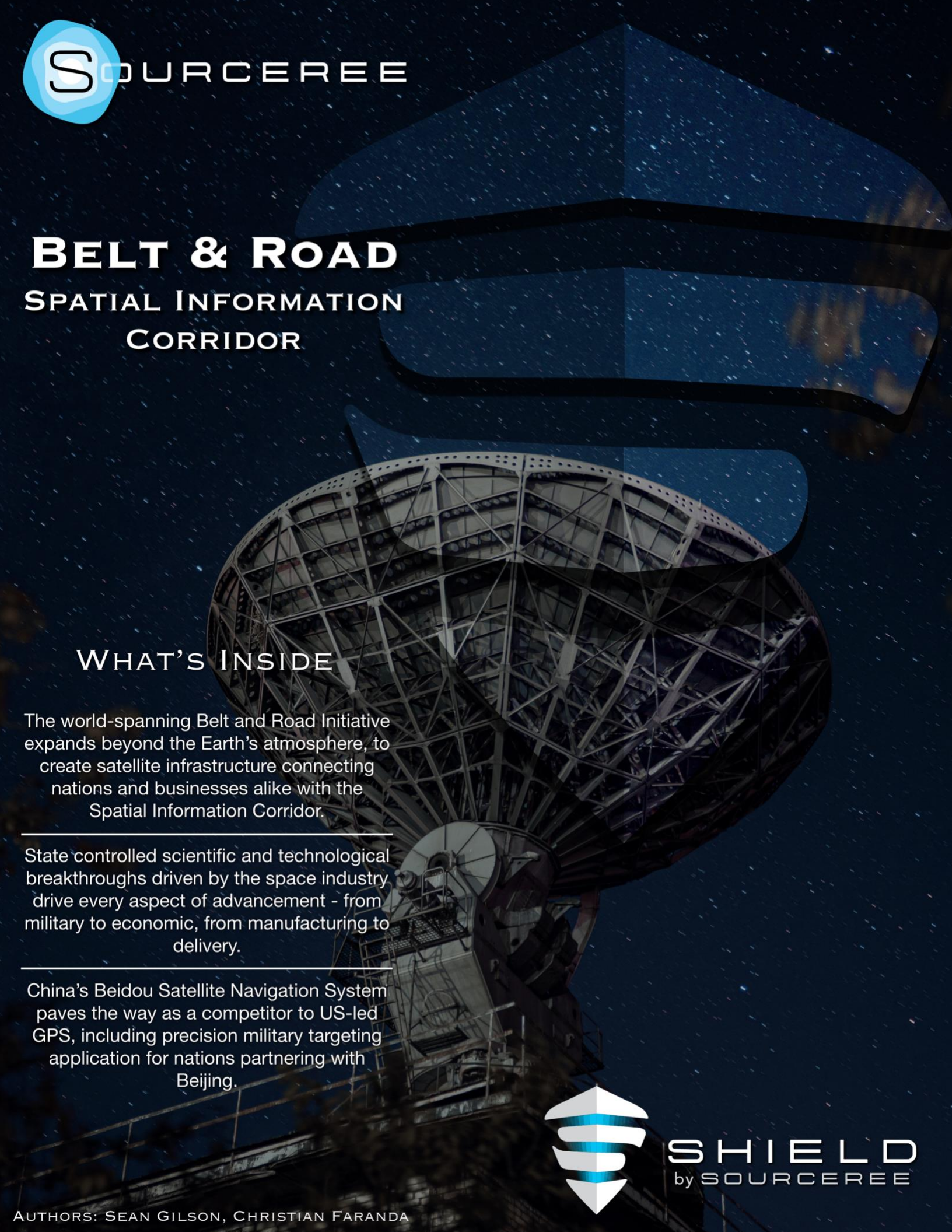
SOURCEREE

Belt & Road

Spatial Information Corridor



What's Inside

The world-spanning Belt and Road Initiative expands beyond the Earth's atmosphere, to create satellite infrastructure connecting nations and businesses alike with the Spatial Information Corridor.

State controlled scientific and technological breakthroughs driven by the space industry drive every aspect of advancement - from military to economic, from manufacturing to delivery.

China's Beidou Satellite Navigation System paves the way as a competitor to US-led GPS, including precision military targeting application for nations partnering with Beijing.

SHIELD by SOURCEREE

Authors: Sean Gilson, Christian Faranda

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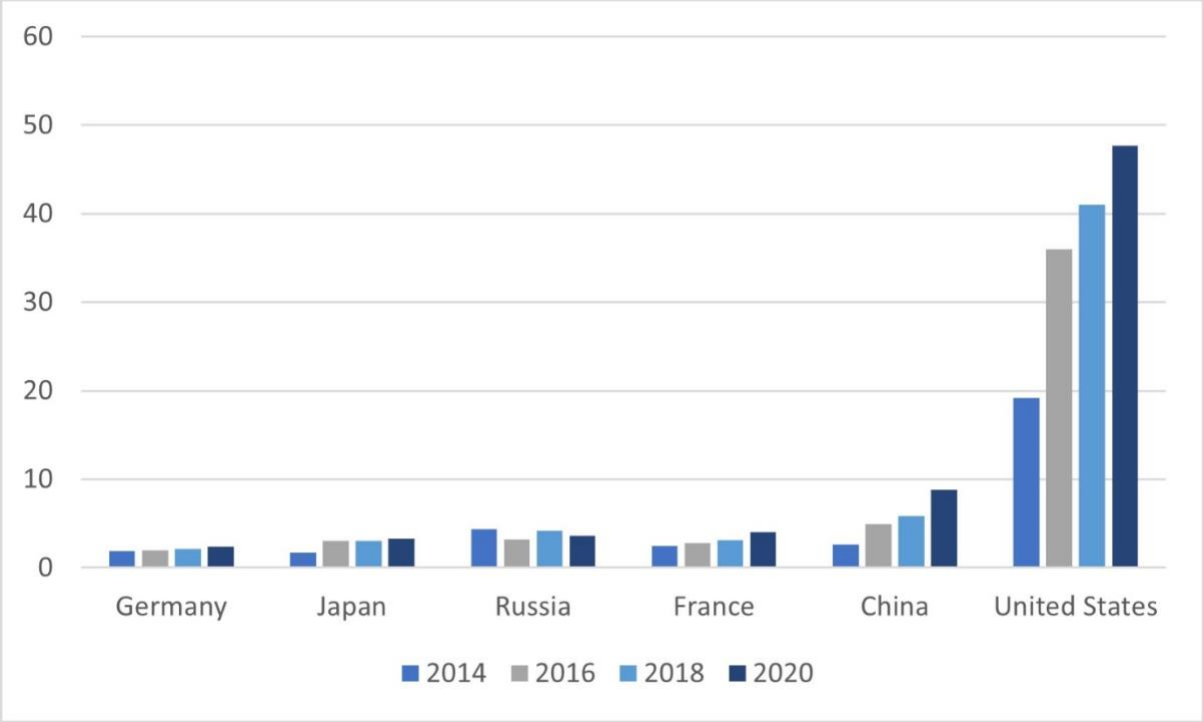
SOURCEREE PERSPECTIVE

The modern great power struggle is reaching new heights, both figuratively, and in this case, literally. China's Belt and Road Initiative's expansion to the space domain, dubbed the Spatial Information Corridor, will be a major shaping effort for the future of space programs around the world, and will affect every aspect of national security and economic stability. If information is the basis for twenty-first century power, then space is the domain through which that power will flow. While much research has been conducted regarding the "new space race" between the United States and China, this research paper seeks to explore beyond the capability to exploit the scientific and technological advantages of a successful space program – to highlight the near earth and terrestrial advantages of tying China's space program to their massive economic engine, the Belt and Road Initiative.

The notion of connectivity has undergone a tremendous change in the twenty-first century. Just over twenty years ago, connecting to the internet meant long waits for dial-up service. Today, immediate access to global connectivity is one driving factor in building a mega-constellation of hundreds of Low-Earth Orbit broadband satellites. The globalization of the world's economy means that connections must go beyond the peripheral access to roads, rails, and waterways. Connectivity now must include real-time virtual communication, a digital infrastructure that underpins and weaves throughout all other forms of connection. China's Belt and Road Initiative (BRI) envisions a next generation digital infrastructure and satellite network around the world.[1] In May of 2017, President Xi Jinping first linked the BRI to China's foreign policy, intentionally seeking out what he called "win-win" scenarios for China and their partnered nations for common development in an attempt to build a "shared future."[2]

China's BRI is broken into several specific enterprises – including a digital silk road, and the Space Silk Road, known as the Spatial Information Corridor.[3] The Spatial Information Corridor allows for the broadest footprint and ability to affect the entire global community. This portion of the BRI is intended for three major efforts: to enable navigation and communication for other BRI efforts; to demonstrate China's technological prowess; and to enable a broader reach for China's international influence. The People's Liberation Army (PLA) will also gain immensely despite numerous denials of a military aspect since the BRI's inception in 2013. Overall, progress in the space domain has been steady across most areas as China works to become a world leader in the space industry by 2045.[4]

As China continues to fuse their military and civilian enterprises, the line between the two becomes increasingly blurred. Where the BRI was once an entirely economic strategy, it is becoming clear that the PLA will be able to pull from those civil projects to enhance their global reach – whether through the expansion of Global Positioning systems, communications, or to anti-satellite (ASAT) technologies to degrade communication and visual intelligence for other nations.



Government Spending on Space Programs since 2014 (in billions USD)[5]

China is one of very few nations in the world with a growing and stable space budget (from 2003-2018, China's spending increased by approximately 350% on their space program).[6] This means that Beijing must be included in future space talks, could be a potential partner for large missions, and possibly a costly nation to exclude.[7] China's expansion as a space power will continue to grow, giving them access to navigation technology and communication infrastructure. By pairing their advances in space technology with products made available to the world market, China has given further credibility to their products, essentially showing the world the quality of the parts they make, which expands their profit margins. And finally, the power produced by incorporating multiple countries into their network of infrastructure offers terrific amounts of influence over other nations' political dealings and increases China's military freedoms. By taking to orbit, China has been able to expand on multiple fronts, increasing their own profitability alongside their potential for power.

OVERVIEW

From Humble Beginnings to Modern Competitor

China initially lagged behind the Soviet Union and the United States as they began the development of their national space program. The first attempts began in 1950 but were largely unsuccessful. It wasn't until 1970 that China launched their first satellite, the Dong Fang Hong-1, making them the fifth nation to put a satellite into orbit (notably, the satellite was the largest to

date, weighing more than the combined weight of all four previous satellites). It would take another 23 years (1993) for China's space program to fully create the China National Space Administration (CNSA) and the China Science and Industry Aerospace Corporation (CASIC), responsible for planning and developing space activities, and responsible for developing space-related technologies respectively. The CNSA took a full ten years to develop the technology to put a man in orbit, when Taikonaut Commander Yang Liwei orbited the Earth in 2003, making China only the third nation to accomplish this feat. With the development of heavy lift rockets, China launched their first lunar lander mission in 2007, followed by several lunar tests including the first ever landing on the far side of the moon in 2018. Most recently, in 2020, China's first interplanetary mission launched for Mars, the same year China's first reusable space plane launched and spent two days in space.

Timeline of China's Space Station Program

Launch date	Spacecraft
29 April 2021	Tianhe
29 May 2021	Tianzhou-2
17 June 2021	Shenzhou-12
September 2021*	Tianzhou-3
October 2021*	Shenzhou-13
March–April 2022*	Tianzhou-4
May 2022*	Shenzhou-14
May–June 2022*	Wentian
August–September 2022*	Mengtian
October 2022*	Tianzhou-5
November 2022*	Shenzhou-15

**The earliest possible date and may change.*

Graphic© Asia Briefing Ltd.

Most recently, China has successfully launched their Shenzhou-12 Spacecraft with three crew aboard, this marks the first crewed mission to China's new space station, Tianhe ("Harmony of the Heavens"). The crew launched June 16 (June 17 by Beijing time), spent three months on the space station and returned to Earth on September 17. Future plans for the Tianhe space station include robotic cargo spacecraft, a longer crewed visit (a duration of approximately six months is planned), and additional orbital modules to be added to the station. Two more modules are scheduled to link with Tianhe to form a three-piece space station called Tiangong 3 ("Heavenly Palace") which will be approximately one-fifth the mass of the International Space Station (ISS). These modules are expected to be assembled next year.[8]

Between its inception in the late 1950s and the turn of the century, the Chinese space program experienced a gradual buildup in terms of technology, infrastructure, and capability. In time, this

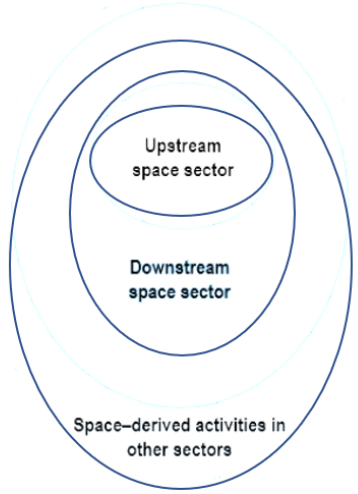
would set the stage for China to become an official major power in space. Combined with the creation of a crewed space program, a new family of heavy-launch systems, its lunar exploration program, and its successful deployment of two space stations, these latest accomplishments demonstrate just how much China's space program has matured in recent decades.[9]

Tying the Space Program to the Belt and Road Initiative

Shortly after the inception of the Belt and Road Initiative, Beijing recognized the expanding nature of the program, and the necessity to go beyond the ancient Silk Road path. To complement the Silk Road Economic Belt and the 21st Century Maritime Silk Road, there now exist many specific areas of enterprise and cooperation, namely: The Digital Silk Road, the Arctic Silk Road, the Air Silk Road, and the Space Silk Road (or Spatial Economic Corridor) just to name a few. Of all that falls under the umbrella of the BRI, it could be easily argued that the aerospace component of the Silk Road, in particular the space domain, represents the largest part, especially in terms of its broad application and ability to reach out and touch the global community.[10]

A Growing Space Presence: China's Economic Expansion to the Final Frontier

With a stable budget to continue growth in the space sector, China has taken a unique stance by connecting their technological advances in one field to demonstrating their technical prowess across all fields. The high-profile space program will help build international consumer confidence in Chinese technology products.[11] This also reorients the narrative toward different space products, which are marketable to countries trying to develop their own space programs, or countries hoping to piggyback on China's.



Scope	Activities
Upstream space sector = scientific and technological foundations of space programs, manufacturing, and production of space infrastructure	Fundamental and applied research, scientific and engineering support, dedicated ancillary services (e.g., insurance), supply of materials and components, design and manufacturing of space equipment and subsystems integration and supply of full systems, space launch
Downstream space sector = daily operations of space infrastructure and down-to-earth activities that directly rely on the provision of space capacity (satellite technology, signals, or data) to exist and function	Operations of space and ground systems, supply of devices and products supporting consumer markets (e.g., GPS-enabled devices, set-top boxes, selected GIS), supply of services supporting consumer markets (e.g., satellite television broadcast)
Space-derived activities in other sectors = New activities in various economic sectors that derive from or have relied on space technology transfers	Activities/products/services derived from space technology but not dependent on it to function (e.g., ad-hoc space technology transfers in the automotive or medical sectors)

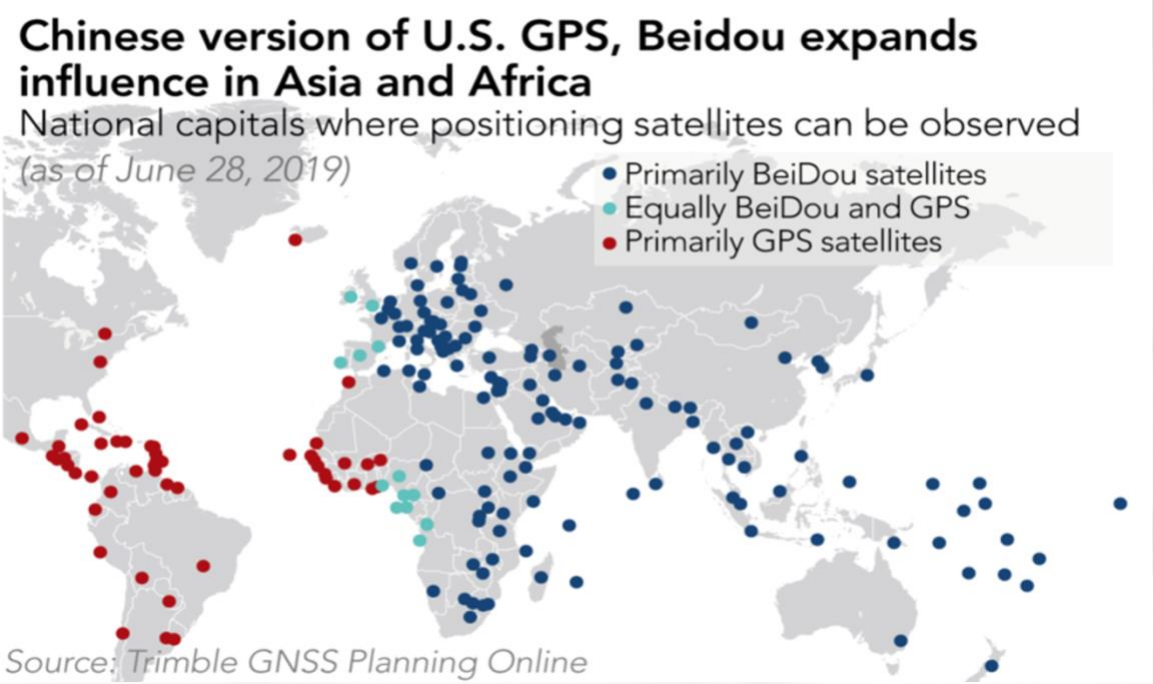
Source: OECD (forthcoming), *Handbook on Measuring the Space Economy*, second edition.

In previous decades, China has relied heavily on importing technologies from other countries like the US. However, laws such as the US International Traffic in Arms Regulation (ITAR) restrictions kept China from obtaining rocket technology for fear it would be converted to ballistic missile technology. This may have ended up helping China, as it forced the nation to discover its own technologies. While these may currently lag behind the US, China has entirely built its own, which means they do not rely on foreign technologies.[12]

China's goals for their space program are primarily linked to improving China's standing in the world of space science, with self-proclaimed goals of a manned space station, a lunar base, and eventual missions to Mars. However, a very different viewpoint is offered by Namrata Goswami of The Diplomat, who stated "Unlike NASA, which is aimed at space exploration and science missions, China's space program has a singular aim – long-term wealth for the Chinese nation."[13] By 2040, estimates say the global space economy will be worth $2.7 trillion, with possibly even more if space mining comes to fruition (Asteroid 2011 UW 158, which came to within 1.5 million miles of Earth in July 2015 contained enough platinum to have an estimated worth of $5 trillion). These ideals are not mutually exclusive, as China has gained economically from advances in technology brought about by research conducted for their space program – a perfect example is the Beidou Navigation System.

Building a Way to See the Map: Global Navigation and Communication

The first of the Spatial Information Corridor's three efforts is to create a global navigation and communication system. A system like this will enable the expansion of other BRI efforts while demonstrating the ability of China to create a system on par, or better than, western nations. China's Beidou system, named for the Chinese name for the Big Dipper constellation which has been used for cross-land navigation for centuries, is a complete global positioning and timing system which is enabled by 42 low and middle Earth orbit satellites. It boasts the ability to provide geolocation to an accuracy of within 10 meters, movement tracking of 0.2 meters per second, and a timing accuracy of 50 nanoseconds, all suitable for civilian purposes. And here, is the first connection to the military aspect of the BRI. A paid, military version of the Beidou navigation system is much more accurate able to determine locations to within 10 centimeters, making it capable for use in precision targeting.



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Taking the Long Way 'Round: Bypassing Cyber Vulnerabilities by Going Through Space

A growing concern from the West is the flow of internet traffic through underdeveloped countries. Internet users have no say over which cable system transmits their data. This becomes a major concern when sensitive information is conveyed through digital means. The internet is made up of many different networks, each of them makes decisions about how to send signals independently from one another. Essentially choosing whichever pathway offers the lowest latency, regardless of physical distance.[15] The cables that carry valuable data can be vulnerable to cyber intrusion, especially in locations where tampering cannot be monitored.[16] In order to build the BRI communication infrastructure, Beijing must create a wired network through multiple nations – including underdeveloped ones. Those underdeveloped nations are at increased risk for cyber-intrusions because they lack the security infrastructure to detect them, and the nations' laws are not robust enough to prosecute criminals for cybercrimes.[17] Since internet protocols don't regulate the geographical location of how a signal is passed, these new networks increase vulnerabilities which must be mitigated – a difficult feat for a country inside its own borders, and nearly impossible to enforce in another nation.[18] This chance of cyber intrusion then presents itself as a global threat, as internet traffic passes through these vulnerable locations.

In order to avoid the necessity of utilizing unsecured locations, one way to (literally) go around the problem is to go up and over through a network of communication satellites. Currently commercial companies like SpaceX have built constellations of small satellites in Low-Earth Orbit (LEO) which can transfer signals over great distances with low latency.[19] China plans to

build their own mega-constellation of communication satellites to have their own access, offering yet another method for BRI nations to stay connected. However, it should be noted that a network fully owned and operated by the Chinese Communist Party will likely suffer from a great amount of control and censorship, as with the current web services in mainland China.

China has stated it plans to expand their Beidou system coverage to most of the countries covered in its "One Belt, One Road" Initiative by 2018 on the way to global coverage in 2020. A feat they have accomplished, with the launch of the final Beidou satellite in June 2020.[20]

Economics Used for Political and Military Power

While China has always officially held to the position that the BRI has never, and will never, have any military application, there are obvious connections which can be exploited by Beijing. The Indian Institute for Defence Studies and Analyses stated that just as the flow of information will be the source of power for the future, military victories will be determined by those states which conceive, design, build, and operate the best information-based technologies to deliver new combat power.[21]

HOW BRI IN SPACE AFFECTS AMERICA

A New Space Race or Cooperative Exploration?

"The US is currently in a situation of refocusing its spaceflight efforts," says Joan Johnson-Freese, chairwoman of the Department of National Security Studies at the Naval War College in Newport, Rhode Island. "We don't have the political will that China has right now. If there's a race going on, their advantage is through political will, not technology." While the United States remains the international leader in spaceflight ability, she said, it is unclear whether that will always be the case. The Chinese space program is rising just as NASA faces difficult growing pains following the retirement of its 30-year space shuttle program. Couple that with China's momentum and the United States handing off a significant portion of the space program to the private sector, and it could mean America would face a losing battle if a new space race were to begin. Though NASA administrator Jim Bridenstine says that "that [space] race is over. We went to the Moon, and we won. It's done. Now we're in a position where we can take our time and make sure we get it right."[22]

China is working quickly to close the technology gap between themselves and the United States. For example, the United States launched its first crewed spaceflight mission in 1961 and its first temporary space lab, Skylab, in 1973. NASA's first long-term ISS module launched 25 years later in 1998. In contract, China launched its first crewed mission in 2003, but only 8 years later launched its first temporary Tiangong space lab in 2011.With the successful launch of the Tianhe-1, China's first long-term space module in 2021, it has matched NASA's nearly 40-year progression from human spaceflight to first space station module in less than 20 years.[23]

Another viewpoint includes working with China, just as numerous other nations have, to build a relationship together, but the United States has held back. “The fears are that if we work with China, it would be to their technological benefit,” Johnson-Freese said. Though the Chairwoman agrees that we should work with China as it is “better to work with people and have some control than have someone off on their own when you’re not involved.”[24] Doing so will require changing the Wolf Amendment, which has banned the United States from working bilaterally with China on space programs since 2011.

Militarization of Space

Although China has been emphasizing its peaceful approach to outer space, suspicions and concerns have been expressed. China’s space program has led to the development of capable anti-satellite platforms. China already has operational ground-based missiles that can hit satellites in low-Earth orbit (as demonstrated by their destruction of a dead weather satellite by ballistic missile in 2007) and is likely pursuing the technology to target geosynchronous orbit satellites says the Defense Department’s annual report to Congress on China’s military capabilities. According to China’s military strategy, an adversary’s imaging, communications, navigation, and early warning satellites would be targeted in order to “blind and deafen the enemy.” [25] The combination of these two factors leads one to believe satellites will be targeted early on in any conflict between developed nations.

BEIDOU NAVIGATION SATELLITE SYSTEM (BDS)

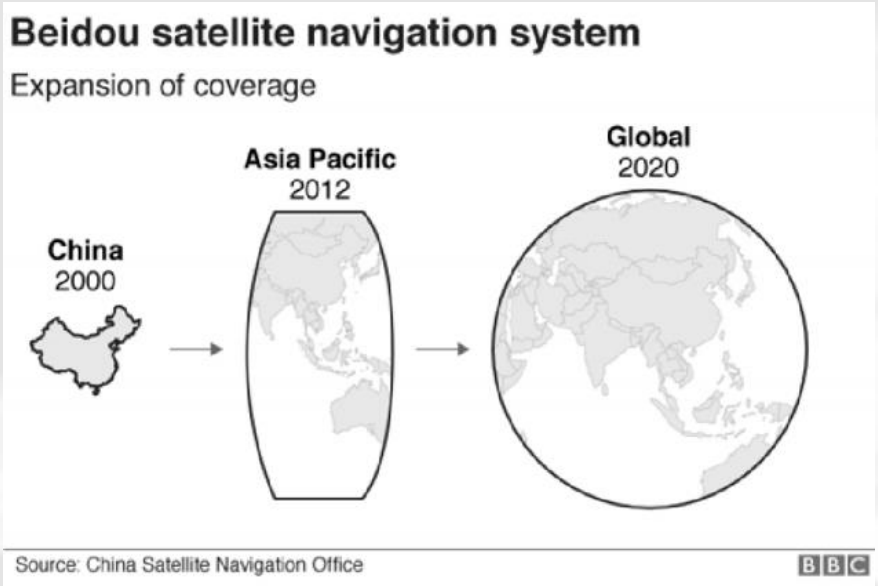
In the late 20th century, China began to explore the development path of satellite navigation systems suitable for national conditions, and gradually formed a three-step development strategy: At the end of 2000, the Beidou-1 system was built to provide services to China; at the end of 2012, the Beidou-2 system was built to provide services to the Asia-Pacific region; in 2020, the Beidou-3 system was completed to provide services to the world.

The Beidou Navigation Satellite System (BDS) is China’s premier space asset. Currently consisting of a constellation of 30 satellites in three different orbits, the BDS has been described by some as being able to provide improved positioning accuracy over that of the U.S. Air Force’s GPS, Russia’s GLONASS, or the European Galileo systems.[26] Countries along the Belt and Road are eager to sign up for its services, and many already have. Like other operational GPS services, Beidou offers services such as humanitarian and disaster assistance, agricultural planning, weather prediction, and navigation. These services provide a huge opportunity in revenue for China, who estimates that the total market for satellite and telecommunications services will be worth about $60 billion in the coming years.[27]

Navigation services based on BDS have been adopted by e-commerce, mobile smart terminal manufacturing, and location services and have been widely used in the fields of mass

consumption. New application models, new formats, and new economies continue to emerge, profoundly changing people's production and lifestyle.

BDS consists of three parts: the space section, the ground section, and the user section.



- Space segment. The space segment of BDS consists of several geostationary orbit satellites, tilted geosynchronous orbit satellites, and medium-circular earth orbit satellites.

- Ground section. The ground segment of BDS includes several ground stations such as the main control station, time synchronization / injection stations, monitoring stations, and inter-satellite link operation and management facilities.

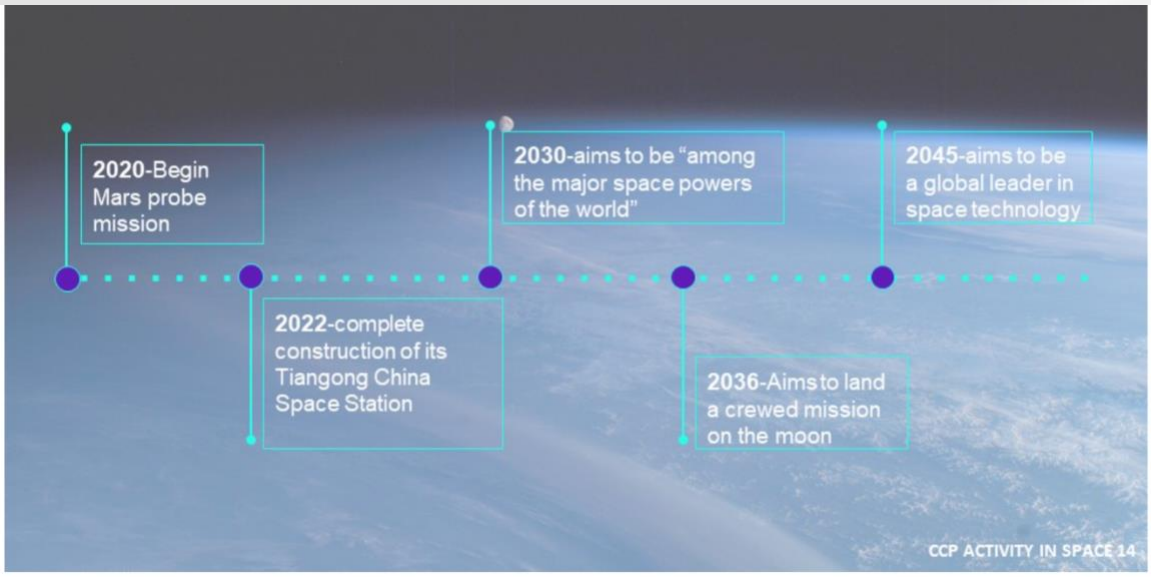
- User segment. The user segment of BDS includes basic products such as chips, modules, and antennae compatible with other satellite navigation systems, as well as terminal products, application systems and application services.[28]

In accordance with the China Satellite Navigation Office's principle of "unified planning, unified standards, and joint construction and sharing", BDS integrates domestic ground-based augmentation resources and establishes a high-precision satellite which is also compatible with other satellite navigation systems. BDS also has capabilities beyond civilian applications – for instance, it has the potential to improve China's missile guidance systems and remove their reliance on US based GPS. Using BDS high-precision receivers provides accuracy to 1-2 meters, decimeter-level and centimeter-level real-time high-precision navigation and positioning services. Notably, the highest resolution BDS offers is only available to those customers who adopt the paid military version.[29] Pakistan was one of the first nations to make this change, dropping their reliance on American made GPS.[30] Following a 2013 agreement, Pakistan was the first partner country to be granted access to BDS restricted high-precision signal for military use. Pakistan's use is intended to be a model for BDS expansion to other BRI participants.[31]

GOALS, OBJECTIVES, AND BENEFITS

China has clearly outlined its ambitions to be a global leader in space and is now competing with the United States' national space program in such endeavors as robotic probe missions and international space cooperation. In addition, the CNSA is directly competing with the US private

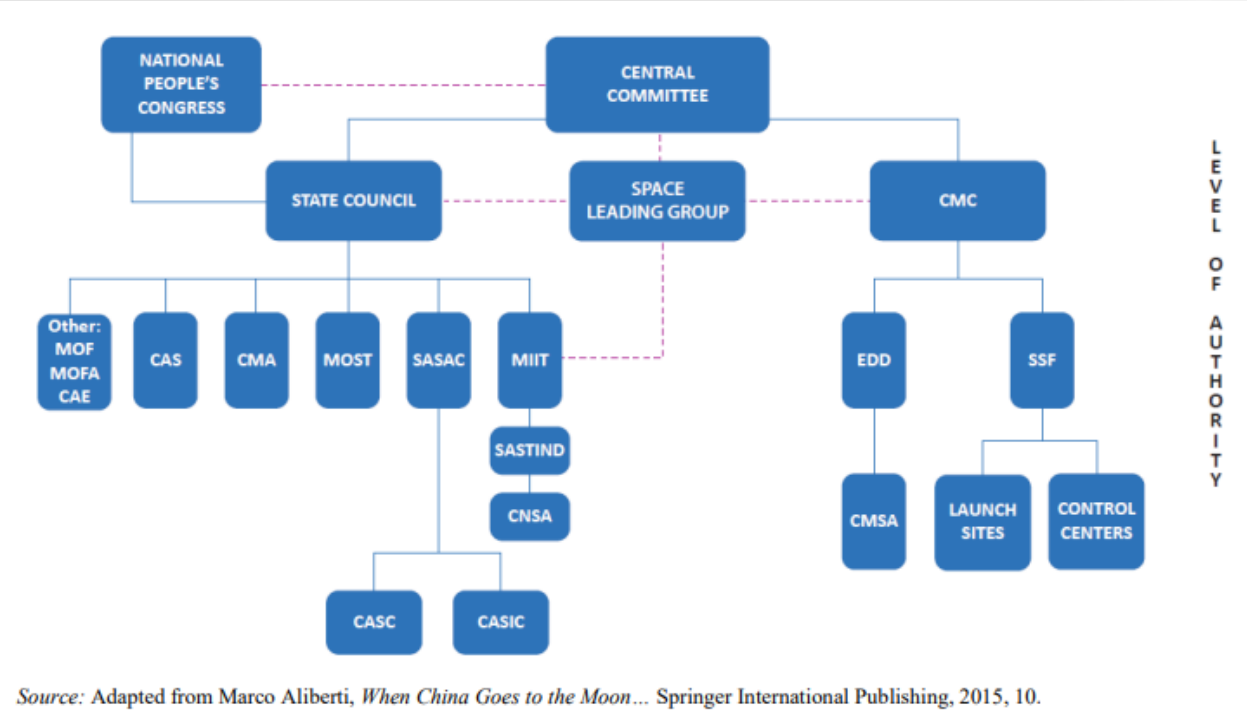
sector in areas such as the development and deployment of constellations of communication and navigation satellites, and personnel and supply launches to manned space stations.



Future Goals of China's Space Program [32]

Beginning with President Xi Jinping's speech to the Chinese Communist Party (CCP)'s 19th Party Congress in 2017 indicated the desire to build an international "community of common human destiny," highlighting China's willingness to work with people of all countries. Xi's remarks underscore a trend in Chinese foreign policy – seeking high-profile roles in existing institutions, while selectively pursuing the establishment of new multilateral mechanisms. An example being the construction of the Tianggong space station – potentially the sole manned station after the United States ends funding of the International Space Station (ISS) in 2024. In May 2018, the military office overseeing China's human spaceflight program announced UN member countries will have the opportunity to use China's space station for scientific research, demonstrating Beijing's ability to benefit diplomatically from identifying and addressing potential gaps in the international community's space needs.[33] Notably, the United States was left out of this invitation because China has been banned from the International Space Station since 2011.

China's space program is directly linked to their military in two distinct ways. First, because China has instituted the military-civil fusion ideal, tying all civilian technology to be useable by the military. And second, the PLA Strategic Support Force (SSF), a new service of China's armed forces established in late 2015, is responsible for most of the military's space warfare mission. China's military plays an important role in organizing and overseeing China's space activities, meaning most of China's ostensibly civilian space activities have dual-use applications (see chart below). China's space policy in effect allows Beijing to continue to develop military space capabilities while publicly claiming to oppose militarization of space.[34] By linking these projects to BRI projects, China is able to provide services to BRI partnered nations, while also expanding their footprint.



Source: Adapted from Marco Aliberti, *When China Goes to the Moon…* Springer International Publishing, 2015, 10.

Acronyms from top to bottom, left to right: Central Military Commission; Ministry of Finance; Ministry of Foreign Affairs; China Academy of Engineering; China Academy of Sciences; China Meteorological Administration; Ministry of Science and Technology; State-owned Assets Supervision and Administration Commission; Ministry of Industry and Information Technology; Equipment Development Department; Strategic Support Force; State Administration of Science, Technology, and Industry for National Defense; China National Space Administration; China Manned Space Agency; China Aerospace Science and Technology Corporation; China Aerospace Science and Industry Corporation.

Notably, the Central Military Commission (CMC) controls the China Manned Space Agency (CMSA), Launch Sites, and Control Centers – which means every space mission must go through the Military Commission.

People's Liberation Army (PLA) Goals for China's Space Program:

- Advanced precision strike assets
- Persistent space-based surveillance
- Single, integrated air and space picture
- Survivable communications architecture
- Ability to contest a broader area beyond China's immediate periphery
- Countermeasures against advanced US long-range precision strike capabilities

FINANCING

By partnering with the BRI Spatial Information Corridor, nations become dependent on Chinese-provided space services. China's sustainment of infrastructure, and sometimes direct operational control of vital resources, can shape the policy choices of states.

China's Space Investments 2012

- China invested approximately $8.3 billion on its space program
- Shenzhou 5 (1992-2003) program cost approximately $2.2 billion
- In 2012, a spokesperson for the China Manned Space Agency stated the country had spent $6.35 billion on human space flight.
- The Chang'e 1 lunar orbiter cost between $130-190 million
- From 1994 – 2012 China invested more than $2.57 billion into the Beidou satellite navigation system.*

China's Space Investments 2020

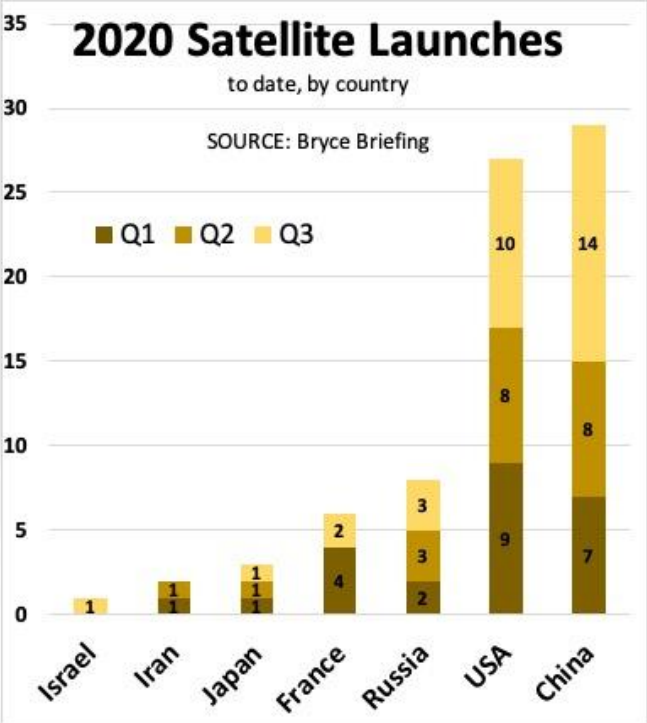
- China invested approximately $8.85 billion on its space program
- Tiangong (Heavenly Palace), China's Space Station cost is undisclosed but estimates based on the International Space Station could significant (ISS has cost around $118 billion over the last ten years)
- Final Beidou satellite launched on 23 June 2020
- Mars Rover Zhurong is launched on 23 July 2020

CONCLUSIONS

China has linked their social, diplomatic, and economic growth to their Spatial Economic Corridor. President Xi Jinping's fusion of Military and Civil infrastructure means growth will continue as the civilian side of China is incentivized to shift to research benefitting the space program. Many Chinese companies are learning from the trials of American companies, like SpaceX and Blue Origin, and using their lessons learned to grow at a staggering pace.

While the US continues to dwarf all other nations in spending, it is becoming abundantly clear that China is quickly approaching the same level of technology at a fraction of the cost, even being able to surpass the number of satellite launches in the third quarter of 2020. It is evident China is utilizing its limited resources effectively. Time will tell if China can maintain this pace, and their eventual dream of becoming a Strong Space Power. China's goal is to become a space power on par with the United States and to foster a space industry that is equal of those in the United States, Europe, and Russia.[35] Notably, China sees much of their space program innovation coming from the Chinese National Space Administration (CNSA) rather than the private sector as is being seen in the United States. NASA has handed over much of the near-Earth space missions to private enterprises, choosing to focus their many decades of experience on long-range missions such as returning to the Moon and eventually sending a manned exploration mission to Mars.

China's technological expansion has been a driving factor in the creation of the Beidou Navigation System, which is an enabler for further projects. BDS allows for both military and civilian tracking, and China's constellation of communication satellites will continue to multiply their political and military might.



Every five years, China announces a new Five-Year Plan, and each of the last several plans have included Space as a central theme for national growth. Since 2016, China has been working diligently to further explore outer space and promote development in all aspects, while the Beidou system has been in the works since the late 1990s.[36] China's linkages between the military and civil sides of their nation mean any and all aspects of their space program may be used for military purpose.

China appears to have both the financial resources and political will to continue to make progress in establishing their national space program, positioning Beijing to assume a greater leadership role in an era of renewed global interest in space exploration. Indeed, a recent Air Force Space Command report put it this way: "China is executing a long-term civil, commercial, and military strategy to explore and economically develop the cislunar domain with the explicit aim of displacing the U.S. as the leading space power."[37] The United States must continue to make great strides in space exploration and technology to remain at the forefront of the world's space programs. China will continue to do the same, likely to come near to, or catch up to the United States, meaning Washington will likely need to decide to enter the next space race now while they have a significant lead, or to work cooperatively with Beijing while they maintain a position of power in any negotiations.

APPENDIX A: GRAPHS AND FIGURES

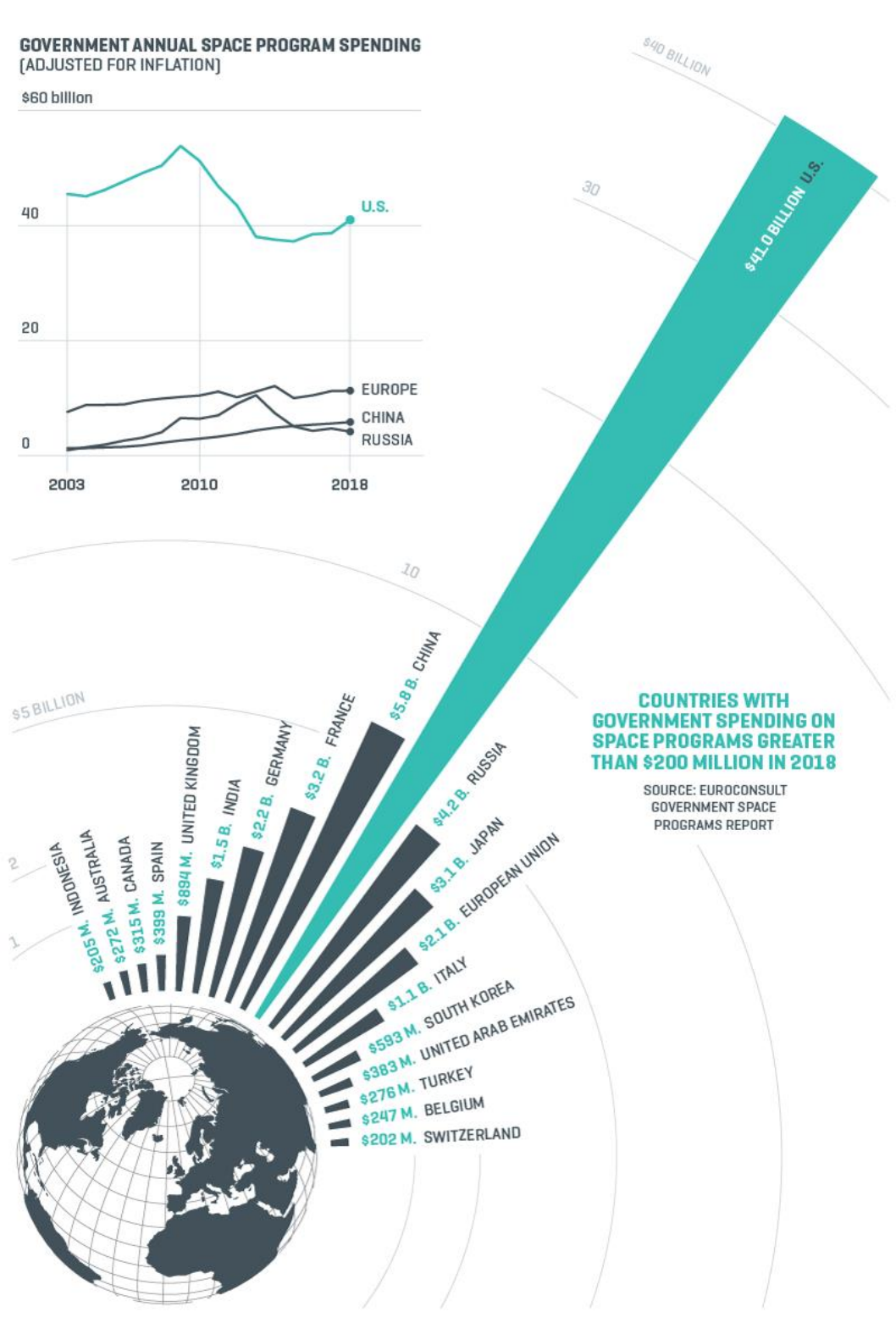


Figure 1: Government Spending on Space Programs[38]

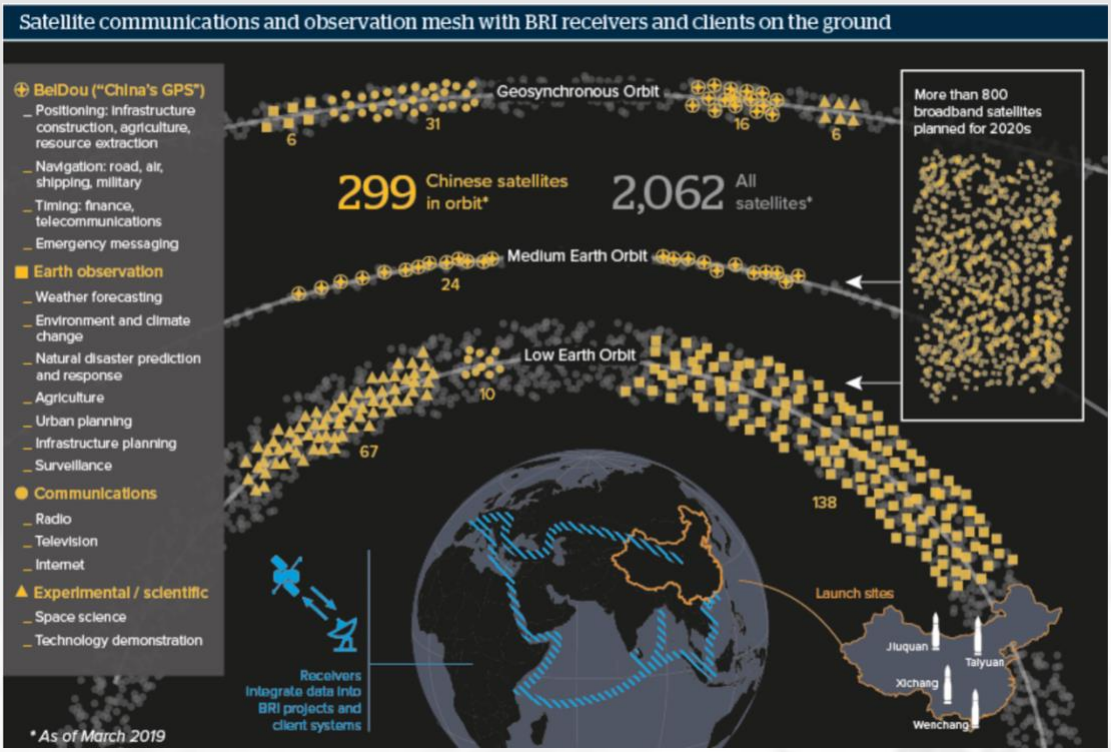


Figure 2: BRI Satellite Mesh Network Depiction[39]

APPENDIX B: LEADERSHIP

All information is presented directly as stated in the China National Space Administration's information translated from Chinese. Sourceree recognizes the inconsistencies in grammar, syntax, and spelling in the below biographies, but feels it is more important to be translated directly than to modify the verbiage.

China National Space Administration	
Individual	**Bio**
 Director: Zhang Kejian China National Space Administration	Zhang Kejian, Joined the work in August 1982, joined the Communist Party of China in June 1992, graduated from the Department of Applied Physics, National University of Defense Technology of the People's Liberation Army with a bachelor's degree in high energy density physics, and a master of engineering in explosive mechanics from the Department of Modern Mechanics, University of Science and Technology of China, and a researcher. Worked at the China Academy of Engineering Physics for a long time. In December 2007, he served as Secretary of the Party Committee of the China Academy of Engineering Physics (vice ministerial level). In August 2015, he served as the deputy secretary of the Party Leadership Group of the National Defense Technology Industry Administration; in September 2015, he served as the deputy director (deputy ministerial level) and deputy secretary of the Party Leadership Group of the National Defense Technology Industry Administration. In May 2018, he served as Deputy Minister and Party Leadership Group Member of the Ministry of Industry and Information Technology, Director of the National Space Administration, Director of the National Atomic Energy Agency, Director of the National Defense Technology Industry Bureau, and Secretary of the Party Leadership Group. Representative of the Twelfth National People's Congress.
 Deputy Director: Wu Yanhua China National Space Administration	Wu Yanhua, male, Han nationality, was born in October 1962 in Taihu, Anhui. Joined the work in August 1984, joined the Communist Party of China in July 1989, on-the-job doctoral degree of Beihang University, doctor of management, researcher, academician of the International Academy of Astronautics. From August 1984 to March 2002, worked in the Planning Department, Comprehensive Planning and Finance Department, and Comprehensive Operations Department of China Academy of Launch Vehicle Technology, successively serving as assistant, deputy director, director, assistant minister, deputy minister, minister, etc. Position. In March 2002, he served as the head of the Finance Department of China Aerospace Science and Technology Corporation. In April 2004, he served as the chief economist and head of the Finance Department of China Aerospace Science and Technology Corporation. In February 2005, he served as a member of the Party Leadership Group and Chief Accountant of China Aerospace Science

	and Technology Corporation. In March 2013, he served as a member of the Party Leadership Group and Deputy General Manager of China Aerospace Science and Technology Corporation. In 2001, he enjoyed the special government allowance issued by the State Council. In September 2014, he served as Deputy Director and Party Leadership Group Member of the National Defense Science, Technology and Industry Administration, and Deputy Director of the National Space Administration.
 Secretary-General: Xu Hongliang China National Space Administration	Xu Hongliang, male, Han nationality, was born in July 1975 in Linkou, Heilongjiang. Joined the work in August 1998, university degree, master of engineering. Served as Director of the System Engineering Department and Deputy Director of the Comprehensive Department of the National Space Administration. In February 2020, he was appointed Secretary-General of the National Space Administration.

Figure 3: Leadership of the China National Space Administration (CNSA) translated to English from http://www.cnsa.gov.cn/n6758821/index.html

Additional CNSA Leadership	
Director: Gao Dongsheng - Ministry of Industry and Information Technology	Deputy Director: Song Ping - Ministry of Industry and Information Technology
Deputy Director: Wang Peng - Ministry of Industry and Information Technology	Deputy Director: Ren Lihua - Ministry of Industry and Information Technology

Figure 10: Leadership of the China National Space Administration (CNSA) translated to English from http://www.cnsa.gov.cn/n6758821/index.html

APPENDIX C: SATELLITES LAUNCHED BY CHINA FOR FOREIGN COUNTRIES SINCE 2012

Country	Satellite	Builder	Launch Date	Cost	Funding
Sri Lanka	Supreme Sat-1/China-Sat-12	Thales Alenia Space	Nov. 2012	$100 million	
Bolivia	Tupac Katari-1	CGWIC	Dec. 2013	$302 million	85% China Development Bank
Laos	Laosat-1	CGWIC	Nov. 2015	$259 million	China EXIM Bank
Belarus	Belintersat-1	CGWIC	Jan. 2016	$281 million	China EXIM Bank
Venezuela	VRSS-2	CAST	Oct. 2017		
Algeria	Alcomsat-1	CAST	Dec. 2017	$260 million	Algerian Space Agency
Pakistan	PRSS-1	DFH Satellite Co. Ltd.	Jul. 2018	$200 million	30% Pakistan 70% China loan
France	CFOSAT	CAST and French National Centre for Space Studies	Oct. 2018		
Saudi Arabia	SaudiSat 5A & 5B	King Abdulaziz City for Science and Technology	Dec. 2018		
Thailand	High-throughput satellite	CGWIC	Est late 2019	$208 million	

Sudan	SRSS-1	Shenzhen Aerospace Oriental Red Sea Satellite Co.	Nov. 2019		
Argentina	Nusat 7 & 8	Satellogic	Jan. 2020		
Indonesia	Paluapa-N1/Nusantara Satu-2	CGWIC	Est. 2020	$220 million	
Nigeria	NigComSat-2; NigComSat-3	CGWIC	Est. 2021	$700 million	China EXIM Bank

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