Hearing Date: April 3, 2025
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Testimony before the U.S.-China Economic and Security Review Commission
Hearing: "The Rocket's Red Glare: China's Ambitions to Dominate Space"

It is a pleasure to get the opportunity to testify before this Commission today. I am thankful for the invitation from Commissioners Kuiken and Sims to provide my perspective on China's rapid space advancements and what it means to our national security.

There is little doubt that China has a strategic intent to develop a robust space presence that competes with the West in all areas: ISR, communications, precision navigation and timing, and tracking. There is also little doubt that China intends to hold our eroding space advantages at risk with sophisticated weapons that range from jammers that can deny virtually every part of the spectrum, on-orbit weapons that they routinely conduct on-orbit tests and tactics, and direct ascent weapons that have been recklessly employed at multiple orbits and altitudes.

For over 2 decades I have been part of the policy discussions, budget plans, and architecture pivots to prepare the U.S. for a contested space environment with a peer adversary like China. While our pace to address this threat is lackluster, it isn't because of a lack of awareness on the part of the US government leadership. Our repeated missteps are more attributable to endless policy debates that rehash old decisions, failed acquisitions, budget uncertainty, and traditional government bureaucracy and infighting. While fixing those challenges in the DoD and IC is important, their repair will still fail to enable the US to compete with China in space.

The reason? China is executing a much broader strategy that involves all the mechanisms of national power in a well-synchronized effort to attain global dominance. While U.S. innovation on the industry side is better than China, Chinese government innovation is greater than ours. The U.S. efforts are not well synchronized, and sometimes even work at cross purposes. In short, China is playing chess, and the West is playing checkers.

The good news is that we've seen this approach from China before with Huawei, where they undercut and infected the global Internet marketplace with capabilities that advance Chinese strategic interests. While the West was slow to react, and had to "disinfect" the networks afterwards, we can recognize the symptoms and act differently.

China's intent is clear. "Document No. 91" emphasizes the need for Military-Civil Fusion in the Defense S&T industry to create a Belt and Road Initiative "space information corridor"[1]. They have established strategic 5G cooperation agreements with state-owned enterprises (China UNICOM, Huawei, and Galaxy Space)[2]. Their objectives are also very clear. By creating a state-controlled global network, China can achieve several strategic goals:

[1] Tai Ming Cheung, Innovate to Dominate: The Rise of the Chinese Techno Security State. (New York: Cornell University Press, 2022), p. 136
[2] China News Network. DOI: June 6, 2020. https://new.qq.com/rain/a2020606A0EYHL00, DOA: August 25, 2021

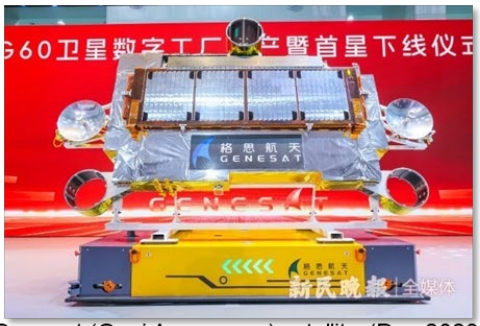
1. Extend and maintain global economic dominance in several other areas such as electronic vehicles, power systems, etc.
2. Dominate infrastructure such as automated port systems, railways, roadways, etc.
3. Conduct cyber warfare and information warfare, to include tracking and targeting dissidents overseas.
4. Conduct global ISR to monitor adversaries and avoid sanctions
5. Conduct long-range fires by integrating weapon systems into the global communications architecture and enabling them to hit moving targets over the horizon.
6. Conduct interference on other satellite systems to create an economic, military, or strategic advantage. Chinese SATCOM systems in LEO that have incredibly vague ITU filings routinely get go-orbital with OneWeb and Starlink satellites.

This is unlike U.S. leveraging commercial technology on contracts to advance military modernization or intelligence collection. This is complete alignment of military and civil activities, where the goals and purposes are the same.

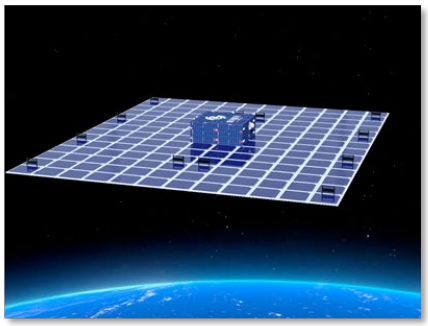
Evidence of this alignment is not opaque. Former Vice Premier Liu He is the forefather of SIGN, China's overall strategy for a globally interconnected terrestrial and space-based network[3]. Premier Li Quang, who orchestrates the State-owned Assets Supervision and Administration Commission (SASAC), initiated the G60 Starlink Industrial Base. "Commercial" space companies like Galaxy Space using assembly, integration, and test facilities at Shanghai Academy of Spaceflight Technology (SAST), which provides weapons technology for the PLA.

There is also evidence of commercial companies utilizing PLA-owned tracking and control sites for commercial companies in Kashgar. Finally, there is clear evidence of industrial espionage at scales that typically dwarf what can be done by any individual company. The Chinese Internet is replete with images of Starlink, Iridium, and AST Mobile doppelgangers that are almost mirror images of the "real thing" (below).

[3] Chenhua Sun, Yongwei Xiao, Weison Zhao, Po Zhou, "Development Conception of Space Ground Integrated Information Network LEO Mobile and Broadband Internet Constellation", Telecommunications Science 33, no. 12 (December 2017): 43-52



Genesat (Gesi Aerospace) satellite (Dec 2023)
Starlink Copycat



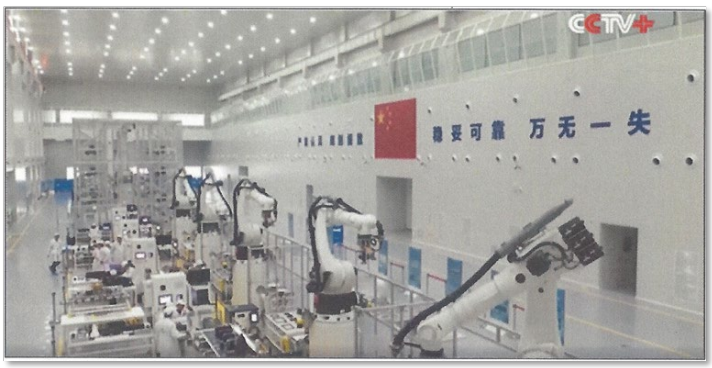
Galaxy Space Fall 2023
AST SpaceMobile Copycat

LandSpace
Falcon/Raptor Copycat

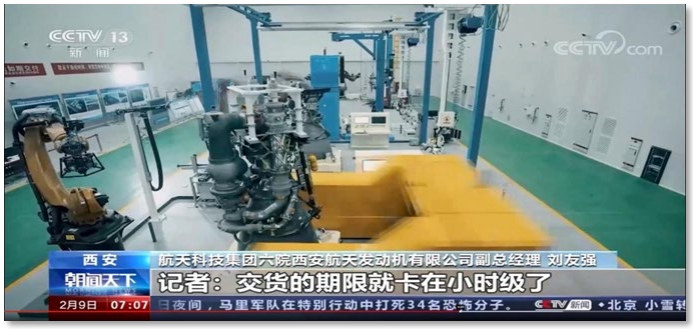
This alignment is not dependent on people placed in key positions or sublets of government facilities by pseudo commercial entities. It is guided by a strategy that is developed and maintained at the very highest level of government. President Xi Jinping chairs the Central Military Fusion Development Commission (CMCFDC), a Politburo level organization he created to align the priorities and efforts of the Central Military Commission and the State Council. It sets the policies, aligns research, and directs funding to support the objectives in the Innovation-Driven Development Strategy (IDDS) and the Belt and Road Initiative (BRI) Space Information corridor. The strategy has several key thrust areas, many of which are extremely similar to Huawei:

1. <u>Capture Key Technology:</u>

The industrial theft at nation-state scale is obvious, and is eerily similar to Huawei's quick rise to technology parity with companies like CISCO. Technology capture isn't limited to theft. In December of 2016, a Chinese appliance manufacturing company known as Midea, acquired 95% of Germany's premier robotics company (Kuka AG) in a takeover bid valued at $4.8B. In November of 2021, they purchased 100%, and the lack of CFIUS laws in Germany made the acquisition easy. Kuka can be found on the assembly lines of many of our Western satellite manufacturers, and it can now also be found in many Chinese satellite and rocket integration facilities.



Kuka at CASIC Wuhan (Shanghai)



Kuka at Rocket Assembly Facility

Kuka is a strategic buy for China. There are now 6 Kuka robotics manufacturing facilities in China, and the capability is fueling the rapid growth of mass satellite and rocket manufacturing in the country.


One of 6 Kuka Plants (Shanghai Songjiang District)

2. <u>Obtain Key footholds in the market to initiate growth</u>

One of the key footholds in the satellite business is frequency. In order to prevent satellite communications companies from interfering with another, the global spectrum is managed by the International Telecommunications Union (ITU), a part of the United Nations that provides frequency allocations to satellite owners. Without an ITU allocation, it isn't possible to operate in the space domain without likely interfering with another lawful transmission. GMS Space, which is the company that plans to fly G60 Starlink as a constellation of over 12,000 satellites, procured another Germany company known as KLEO Connect in order to obtain their valuable Ka ITU filing. This is exactly the kind of foothold that helps accelerate market entry. Another valuable foothold is terrain where satellite control antennas can be placed. There are already examples of Chinese satellite control sites in multiple countries that have now been locked behind security fencing and are operated exclusively by Chinese nationals. Their enthusiastic welcome, then complete ownership by China, is reminiscent of China's port infrastructure around the world.

3. <u>Subsidize Industry to Undercut the Global Market:</u>

China's approach to subsidies is creative. National level policies are established at the Central Committee to increase investment in space, but they are distributed and executed at the Provincial and Municipal level. The investments are backed by the highest level of Party governance: the National Development and Reform Commission (NDRC) and the Financial Economic Leading Group (FELG). However, the Provinces are able to specialize in and attract targeted talent and investments in specific areas (rocket assembly, engines, spacecraft design and manufacturing, etc.). Evidence of the scope of the subsidies is found in Provincial-level action plans:

- Yizhuang Area (Beijing) "Commercial Space High Ground" Policy, February 2024
- Shangong Provincial Policy, January 2024
- Guangong Province, "Nansha New Area" policy

The subsidies are in the billions of dollars, and range from R&D, to infrastructure investments, to insurance costs, to ITU filing rebates, to loan financing.

So, while the U.S. is debating whether and how to subsidize technologies like fiber to undercut U.S. satellite services, the Chinese subsidies are resulting in a massive expansion of facilities, technology, and manufacturing that dwarf the commercial growth in the United States (see Attachment 1, Statistics of China Space Growth). The most recent public-private partnership is the massive satellite manufacturing and launch complex being built on Hainan Island. The complex is astonishing: it will have a mega-satellite factory in the middle that can feed 16 liquid launch pads (one a sea-launched pad), quadruple the 4 liquid launch pads currently operational on the island.

4. <u>Build manufacturing at massive scales</u>

Enabled by these massive studies, and lubricated by an incredibly permissive regulatory environment (environmental, safety, zoning, etc.), Chinese space manufacturing capacity has matured a light speed. There have been 26 high-rate satellite manufacturing facilities built within the past 3 years. The G60 "Starlink" Satellite Smart Factory began earthworks in Feb 2022, and completed their first satellite production at the plant in December 2023.

The CAS Space rocket manufacturing facility began earthworks in December of 2020 and was completed by October of 2022 (see below):

The below satellite super factory with an annual production rate of over 1000 satellites in Wencheng is on track to start operation in June:

One of the most recent additions is the new CAST factory in Hangzhou. It is being built to deliver the SATNET mega constellation.

Their launch facilities are growing at a similarly blistering pace. There have been 21 launch-related companies established in the past 3 years, and over 7 different launch complexes developed (see Attachment 1).

5. Manipulate seams in the regulatory market to gain an advantage:

The internal regulatory environment within China is extremely permissive. The Chinese regulatory body equivalent to the FCC and FAA, known as the Ministry of Industry and Information Technology, is over-permissive compared to US safety standards. China's Wenchang Space Launch Center is located right next to a Hilton hotel, enabling guests to watch launches from their balconies. Even though China's standards for minimizing harm may not be uniform with the West, there appears to be no concern by U.S. regulatory bodies that China's opaque ITU filings may present harmful spectrum interference issues. The U.S. regulatory bodies have not raised concerns with how its regulations slow US operators as compared to their Chinese or other foreign counterparts. The below table describes some of the greatest standards misalignments that create regulatory asymmetry and slow down U.S. space industry growth:

Rule	U.S. License	Non-U.S. License
Operations during orbit raise	Requires separate authorization per launch (and increased fee)	None needed
Operations during de-orbit	Requires separate authorization per launch (and increased fee)	None needed

Debris mitigation plan	Must file	None needed
Federal coordination	Entire Space/Ground system must be coordinated across USG	Coordination only tied to earth stations operated in the U.S.
ITU Filings	Must file entire system with company ID	Can file partially and anonymously

Once filings are made, competitors—generally ones that are licensed and often funded by foreign governments—are permitted to "game" the U.S. regulatory process to slow each other down, inserting objections that might give a particular company a timing or other regulatory advantage. Not only does this behavior encourage several U.S. companies to make filings overseas, but it most clearly advantages China who is allowed to sidestep this counterproductive gamesmanship.

The other mechanism China uses to manipulate the market is to use their integrated military-civilian workforce to overwhelm standards bodies like the ITU that are *consensus-based*. China will typically "rush the field" with massive numbers of personnel that can overwhelm the agenda for the regulatory bodies that oversee international spectrum, such as the ITU and Word Radio Conference (WRC) forums. In contrast, the U.S. holds a convoluted process to determine its positions, including allowing operators owned by foreign governments to manipulate the outcomes. Worse, critical forums like the 2027 WRC, which sets the agenda for future ITU forums, will likely be hosted in Shanghai where the Chinese have a home-court advantage to "rush the field". Combine that with the fact that U.S. persons are limited and have IT and communications restrictions when they enter the country, and you have a perfect storm for the U.S. to take massive policy losses that could harm our interests for generations. These kinds of losses are big: when the agenda for future ITU forums is set 4 years in advance, opportunities to correct past mistakes are few and far between.

6. <u>Expand into global markets:</u>

The strategy played by Huawei is most likely going to be employed by China space companies as well. They will first expand into Southeast Asia markets where space coverage is easier, and the regulatory environment is in their favor. They will undercut the price and outpace the expansion of Western companies and offer additional incentives like funded schools and highways to sweeten the deal. Finally, they will slowly expand along the BIR to Africa, the Middle East, and South America.

7. <u>Create catered environment in global regulatory bodies</u>:

Once enough favorable conditions are met across the globe, the Chinese will leverage country partnerships to create even more favorable conditions within bodies like the ITU (like the World Health Organization and other international bodies).

Recommendations

The United States' greatest power in global competition is the innovation and speed of its industrial base. While problems within the DoD must be fixed, they alone cannot help us maintain parity with China. The United States needs reforms that leverage our strengths, create a level playing field for our industrial base, and gives the DoD greater access to industrial innovation and speed:

1. Regulatory Reform: Both the FAA and FCC need to institute serious regulatory reform with the objective of maximizing industry ability to compete on a global scale while keeping prudent (but not onerous) attention to both safety of U.S. citizens and the environment. Previous attempts to create streamlined regulations (e.g., FAA's Part 450) have only elongated the process and created increased reporting requirements that require even larger regulatory staffs and efforts. Regulatory reform should include the following elements:
    a. Contract the FCC and the FAA from their expansive focus back to the original chartered intent of the organizations. For example, refocus FAA's Office of Commercial Space Transportation (AST) on issues specifically related to their regulatory scope: to protect the uninvolved public. Provisions such Conditional Expected Casualty (CEC) risk, historically utilized as a tool for launch, were codified into Part 450 for all re-entry events, regardless of whether safety is a concern.
    b. Fix the massive amounts of ambiguity that exist in regulatory documentation that make compliance subjective and evaluation processes ill-defined.
        i. Parts of 450 are inherently vague, making the prediction of licensing paths impossible. Compliance guidance for nearly all the most complex or new technical requirements in Part 450 remain unpublished, since Advisory Circulars, intended to help clarify Part 450 after instantiation, have rarely been published.
    c. Repair the overlap between approvals required from the multiple U.S. Government agencies. While the FAA and FCC are responsible for both launch and spectrum respectively, there remains a significant amount of overlap of Part 450 with other agency requirements (NASA, DoD). When input is requested from those agencies, the approval process becomes multi-threaded. The regulatory bodies need to work more quickly to de-conflict inter-agency direction.
    d. The use of the National Environmental Protection Act (NEPA) to constrain industry growth, almost for that purpose alone, runs counter to national security interests. The recent bi-partisan condemnation of the California Coastal Commission denial of additional SpaceX launches at Vandenburg (for dubious reasons) is germane.
        i. Limit application of NEPA to proposed actions affecting the U.S., in accordance with the language of the act. NEPA does not apply to the globe, nor to the space environment. It is also not relevant to re-entry events, particularly if the de-orbit has already been certified.
        ii. To expedite the construction of infrastructure and increase U.S. launch cadence, the head of various agencies (Air Force, NASA, the Corps of Engineers, Coast Guard) should apply exclusions to NEPA for all actions that involve the national security interests of the U.S. and for which such exclusions are permissible under the law.

2. Regulatory Approval Reform: both the FCC and the FAA desperately need regulatory reform. Previous attempts to create streamlined regulations (e.g., FAA's Part 450) have only elongated the process and created increased reporting requirements that require even larger regulatory staffs and efforts. Institute the following changes:
    a. Mandate a "shot clock" for each FCC and FAA submission, requiring regulatory bodies to comply with aggressive filing timelines that match or exceed China.
    b. Applications that are still pending at the conclusion of the shot clock should be deemed granted.
    c. The U.S. should change their regulation approval processes and standards to get uniformity with non-U.S. licensees.
3. Engage in Regulatory-fare to build parity with China:
    a. Strengthen and align Western regulations related to theft of technology, manipulation of markets, and exploitation of international forums
        i. Strengthen EU's Foreign Direct Investments process to include blocking or suspension power like CFIUS
    b. Prevent Chinese domination of the WRC and ITU agendas by overpowering consensus-based rule forums.
        i. Increase U.S. participation at industry and government levels
        ii. Protect "do no harm" exceptions at the ITU that enable U.S. companies to move quickly while the bureaucracy searches for a position. China uses consensus voting to block "go fast" provisions that put them at a disadvantage.
    c. Create a more agile tempo at the ITU and WRC that enables rapid adjudication of proposals to keep up with technology changes and missed manipulations.
    d. Increase the priority of tracking Chinese mega-constellations at the USSF Commercial Integration Cell at the CSpOC to monitor both co-orbital behavior as well as potential RF interference.
4. Create more public-private partnerships that incentivize the growth of space-related launch infrastructure, space technology, and manufacturing. Efforts taken on by Space Florida need to grow to other high-technology regions across the U.S.
5. Flexible contracting and acquisition for the DoD. While the recent adoption of Other Transaction Authorities has enabled the DoD and IC to move more quickly, adoption of OTAs is limited for multiple reasons. Consider other vehicle types or FAR/DFAR modifications (such as what is being proposed by SASC and FoRGED). Look at expanding the use of service-type contracts to lease commercial space capabilities until contracted purchase price is met.
6. Stable budgeting environment. While the challenges of delayed budgets and continuing resolutions are well documented, consider creating special funding and budgeting provisions for DoD and IC efforts that involve a minimum modification of an available commercial service. Such structures may incentivize companies to develop commercially viable capabilities at their own risk and incentivize the DoD and the IC to avoid requirements creep in exchange for speed. There are examples of specific funding types such as SCN (Ship Construction New) that were intended to fully fund the procurement of a specific item and enable execution flexibility. In the early days of the Missile Defense Agency, they had only "one color" of money that enabled them to solve R&D, Procurement, or Maintenance problems with great flexibility. Similar funding vehicles could be developed for critical industries such as space.

Attachment 1

Statistics of China Space Industry Growth

These statistics are provided to demonstrate the amount of growth in the Chinese space market, and to highlight 4 specific points:

1. The speed of their standup from conception to operational capability
2. The size/scale of standup in terms of square feet, numbers of facilities, and size of government investment.
3. The balanced investment strategy across spacecraft manufacturing, launch, and spectrum.
4. That the schedule is roughly on target: other investments, such as real estate, have been overprovisioned and a general failure. The scale of space investment is yielding results, and while some skepticism is warranted, complete skepticism is not.

Rocket Engines

In 2024, CASC vowed to prioritize engine development "to meet urgent demand in the commercial market". Since then, the pace and scale of rocket engine development has only accelerated. Today there are approximately 36 different liquid rocket engines in development by various companies (YF-100K, YF-102, FY102-R, YF-209, Thunder-R1, Tuanhuo-12, Cangquing-50, JD-2, TQ-12, Longyun, and Yuanli-85). Of these rocket engines, 24 of them are designed to be re-usable. Of these 36 different rocket engines, 20 of them have conducted a successful static fire test within the past 3 years, and 6 of them have been used operationally in the past 3 years . Of those that reached a successful static fire test, the average time from estimated initiation of development to static fire testing was only 45 months. There are 22 known production facilities, and 10 new engine and rocket test facility complexes distributed across China, with enough production capacity to satisfy the demand of their large rocket industry. Rocket engine development is a huge priority for the Chinese government: major players like AALPT, the sole engine provider for China's fleets of Long March rockets, vows to develop at least 8 engine models in 9 years between 2021 and 2028, as well as the CAS Institute of Mechanics who is eagerly to develop a Merlin-1D equivalent gas-generator cycle kerolox engine. But most important of all, Beijing is leveraging its commercial space sector with policies, incentives, and government-led initiatives such as the Rocket Street inside the city of Beijing.

Rocket Companies

China has approximately 11 viable rocket companies (iSpace, Landspace, Galactic Energy, Space Epoch, CAS Space, Deep Blue Aerospace, Space Pioneer, Orienspace, ExPace, ChinaRocket, CASC Commercial Rocket) and 3 liquid engine developers, one of which even provided reusable engines to CASC for 3 VTVL tests, an embarrassment to AALPT who monopolized rocket engines in China until the opening of commercial space in 2016. Except for the state-owned CASC, these rocket companies are private companies and are in average only 7 years old . Across these companies, there are 6 heavy lift variants (Pallas-2, Hyperbola-3B, Kinetica-2 Heavy, Kinetica-3 Heavy, Tianlong-3H, Yinli-3) and 29 small to medium lift rockets. Across those variants, 20 (of 35 rockets) or 57% are being built as re-usable rockets. 73% (11/15) of the non-reusable rockets are in full operations, while 20% (4 of 20 useable rockets, LM-12A, ZQ-3, Hyperbola-2/3, Nebula-1) of the reusable rockets have completed significant "hop tests" that demonstrate proficiency in re-usable design. While much of the rocket companies are

considered “commercial”, the Chinese government investment into rocket manufacturing in 2023 alone was $833M, according to CASIC.

Launch Complexes:

There has been a staggering growth in launch complexes in China that far dwarfs the launch complexes in the United States and Allied countries. The total number of launch complexes in China is 6, including a sea launch port and of those 5 launch complexes, 2 have developed in the past 5 years.. Some of these launch complexes are massive: the 5 new launch sites in Mongolia for commercial rockets spreaded across an area roughly 38 square miles at the Gobi Desert, each designed similar to Falcon-9’s, and the newest launch complex on Hainan Island will eventually grow into a satellite and rocket industrial and launch hub with at least 7 launch complexes covering 3.86 square miles. The total number of launch pads across these launch complexes is also staggering: there are 17 launch pads, 5 of which can support heavy lift, and 3 of which can support re-usable rocket launch recovery. Those that can support re-usable rocket launch and recovery have significant infrastructure on sight to support refueling operations. The new Hainan commercial launch site has a new dedicated propellant and cryogenic gas plant and has enough tanks for METHANE, LN2 and LOX to support 4 launch pads for more than 60 launch missions annually. The speed with which these launch complexes have stood up is similarly astounding. Typically, the span of time from ground-breaking to operations for the newest launch pads is only 6 months. Many of these complexes, to include the roadways and infrastructure that support them, are resourced by the Chinese government. The Hainan Island Complex, a mixed use commercial and government space complex with significant government support is astonishing. Recently, Beijing’s mouthpiece news media CCTV just showcased a scale model last week on national TV with 16 liquid launch pads, quadruple of the total 4 liquid launch pads currently operational on the island.

LEO Satellites:

There are roughly 37 LEO satellite manufacturing companies in China. About 11 of those companies are listed as LEO SATCOM companies, but 20 of them provide dual-use missions (PNT, ISR, etc.). 64 (24%) companies are less than 10 years old, but between them have put approximately 672 functional satellites on orbit in that period of time. It should be noted that many of them share similar orbit parameters (altitude, inclination, RAAN) with their western counterparts (SpaceX, Oneweb, etc.). They are postured to quickly ramp into high-rate production. Within the past 3 years, there have been 3 “mega factories” built and another is nearing completion. These mega-factories are massive: The CAST factory in Hangzhou is advertised to be able to manufacture 1,000 lasercom terminals and 120 feeder link antenna a year and has supplied satcom payloads to China’s SatNet mega-constellation satellites being launched since 2023. The Geely’s GeeSpace factory claims to be able to produce 500 satellites a year, Galaxy Space’s factory near Shanghai is purported to have a 300 to 500 a year capacity, and a satellite super factory in Wenchang is advertised to manufacture more than 1,000 satellites a year and is expected to be operational in June. Each of these mega-factories are being built at a blistering pace: the Wenchang facility went from ground-breaking to expected operations within a year. The second phase of the CAST Hangzhou factory with a floor area of 134,800 m2 to crank up more subsystems for SatNet satellites went from ground-breaking in May 2024 to expected operations later this year. A sizeable amount of these investments has been made by the Chinese government. For example, the Hainan commercial space launch site will provide a vertically integrated hub-and-spoke satellite manufacturing infrastructure built by the government with the “Satellite Super Factory” and its adjacent subsystem and

component manufacturing plant to produce more than 1,000 satellites per year and a reusable launch vehicle complex to encompass the future reusable rocket programs

ITU Filings

All of that manufacturing is on pace to feed the voracious ITU filing pace of the Chinese government. In total, the Chinese government has submitted filings for 74,424 satellites between 500 and 900km. Many of these filings are within frequency allocations that overlap with other US satellite companies (11.7GHz and 13.25 Ghz), and companies like Huawei are moving into Ka and DTD frequencies (S-band).