7 JANUARY 2024

THE FINAL FRONTIER FLASH

Developments & Analysis
of the Space Domain

(@johnpisaniphoto)

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Catalog

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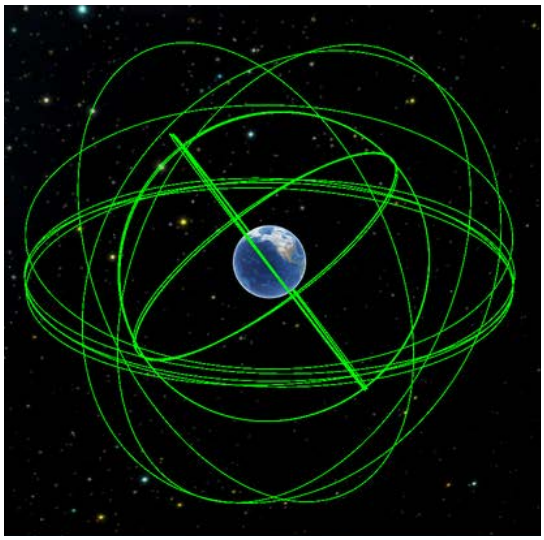
China Augments Beidou Constellation & Bombs Home

26 Dec: China launched a Long March-3B with a Yuanzheng-1 upper stage from Xichang with two backup BeiDou-3 navigation satellites (BeiDou-3 MEO-25 & MEO-26). Both were sent to Medium Earth Orbit (MEO) and are the 57th and 58th of the BeiDou family, and the second and the third to act as a backup satellites. Launch Video. Booster inbound video… take cover!

- MEO-25 and -26 are in 21,532 x 22,193 km orbits with an inclination of 55°.
- The satellites were developed by the China Academy of Space Technology (CAST) under CASC, the country's main space contractor.
- Beidou is China's own global navigation satellite system (GNSS) to rival U.S. GPS, Europe's Galileo and Russia's GLONASS systems. China completed its construction in mid-2020.
- China embarked on building the BeiDou constellation in 1996 after it suspected two of its three missile tests over Taiwan failed due to their reliance on GPS.
- According to one PLA Colonel at the time: "It was a great shame for the PLA … an unforgettable humiliation."
- In 1996, China decided to build its own navigation system, to be completed within 25 years. Their goal was to establish truly independent military command and control, and precision missile guidance and tracking.
- The end result was the establishment of the independent GNSS and PNT systems, the PLA Strategic Support Force, and the development of China's missile capabilities, to include cruise missiles, ballistic missiles, and hypersonic missiles under the PLA Rocket Force.
-Watch short Video on the history of BeiDou.

(@SpaceIntel101 via X)

BeiDou Satellite Assembly (NASA Space Flight)



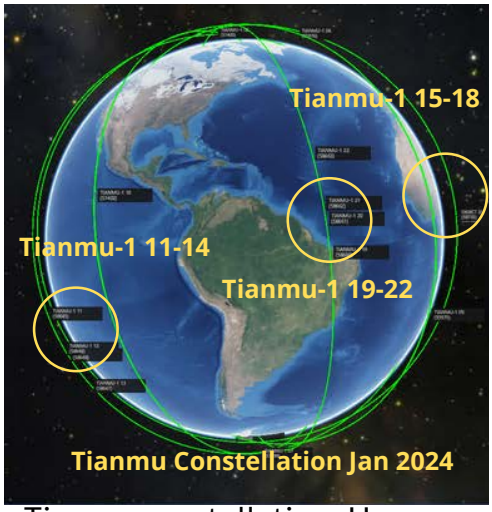
BeiDou-3 Constellation 36 Active Satellites (28 MEO, 4 GEO and 4 IGSO)

Mission Patch (NASA Space Flight)

"Jake From State Farm Insurance is Holding on Line 1" (@AuerSusan via X)

China Launches 3x KZ-1A w/ 12 Tianmu Satellites

25/27 Dec 2023 & 5 Jan 2024: China launched three Kuaizhou-1A (KZ-1A) rockets from Jiuquan, each with four Tianmu-1 meteorological satellites. The first launch placed the Tianmu-1 11-14 satellites into orbit, the second carried Tianmu-1 19-22, and the third carried Tianmu-1 15-18.. There are now 22 Tianmu satellites in Low Earth Orbit (LEO). Per official Chinese sources, the Tianmu constellation "will be mainly used to provide commercial meteorological data services." Launch 1 Video. Launch 2 Video. Launch 3 Video.

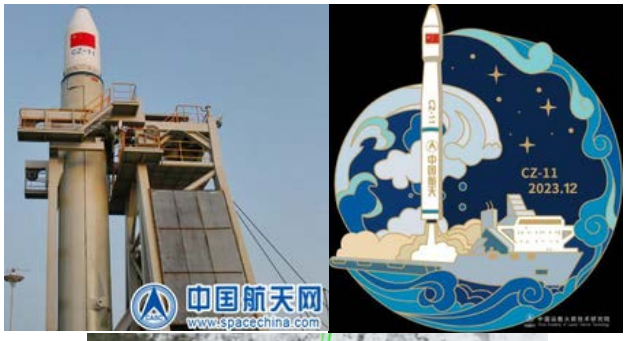


- All 12 new Tianmu-1 satellites are in a similar orbit with the other Tianmu satellites, 528 x 512 km and 95.1° inclination.
-The Tianmu 1 constellation is intended to provide global commercial meteorological data services, including numerical weather forecasting, typhoon monitoring and forecasting, and climate change research.
- All 14 Tianmu satellites launched in 2023, from Jiuquan.
  - Tianmu 01 and 02 launched in January 2023 on a GalaxySpace CERES-1 rocket.
  - Spacecraft 03-06 launched on a KZ-1A in March 2023.
  - Tianmu satellites 07-10 launched on a KZ-1A in July 2023

- Analysts do not yet know the final number of satellites for the Tianmu constellation. However, Gao Wei, strategic operations director of the Tianmu 1 constellation, told CCTV+ "By 2025, our Tianmu 1 system will be basically completed and will provide stable service for various user categories."

LM-11 Sea Launch of Three Shiyan-24C Satellites

25 Dec: China launched a Long March-11 from a sea-based platform off the coast of Yangjiang, Guangdong Province, China. The rocket carried 3 Shiyan-24C satellites to LEO. According to official sources, the three Shiyan-24C satellites "will be mainly used for space science and technology experiments". The trio joins the Shiyan-24A/B satellites which China launched in June 2023. Launch Video.



- The three Shiyan-24C are in a 541 x 544 km orbit with a 95.6° inclination.
- The satellites are expected to contribute to a multitude of experiments, including those related to Earth observation and telecommunications. China has not publicly detailed Shiyan's specific scientific objectives.
-Shiyan 24A & 24B were launched on the 2nd CAS Space Kinetica-1 back in June 2023, a launch where most of the payloads remain unidentified.
- **Interestingly, the SY-24 satellites are nearly co-planar with the SJ-6-05A/B satellites launched on 9 Dec 2021.**
-In Feb 2022 Feb, analysis from LEO Labs indicated SJ-6 05A and 05B had setup for rendezvous and proximity operations (RPO).

China: More Internet Technology Demonstrators

30 Dec: China continued to launch Internet test demonstration satellites aboard a Long March-2C from Jiuquan. As with other Internet demonstration launches, there is confusion as to how many were actually on-board. While China announced the launch of a single "satellite," the space catalog is tracking three objects, only one of which is listed "active" and the other two as "unknown." For what it's worth, the launch insignia patch has three stars. Launch Video.

- The Chinese named the satellite(s) "Weixing Hulianwang Jishu Shiyan" (WHJS) which translates to "Satellite Internet Technology Demonstration Satellite," or something similar.
- The launch placed all three objects into a ~940 x 930 km orbit with a 50° inclination.
- Analysts require more observations to determine if all three objects are maneuvering/operational.
- This launch appears to be similar to another WHJS launch (2023-095) on 9 July 2023. There was also initial confusion regarding the number of satellites on that mission, with China announcing a single satellite, but actually two maneuvering objects were aboard. That launch patch has two stars.
- Both launches, from Jiquan, used a LM-2C with a YS-1 upper stage. However, the 30 Dec launch (2023-212) resulted in the payloads being deployed to a lower altitude (SMA 934.5 km vs 1,111.4 km). The inclinations also differ from 2023-212 at 50°, compared to 86.5° for 2023-095.
- China conducted five Internet Test Demonstrator launches in the last 6 months of 2023:

1. 9 Jun 2023: Longjian-3 satellite from Jiuquan, using a KZ-1A. (471.9 km / 49.1°)

2. 9 Jul 2023: 2 WHJS satellites from Jiuquan, using a LM-2C with a YS-1 upper stage (1,111.3 km / 86.5°)

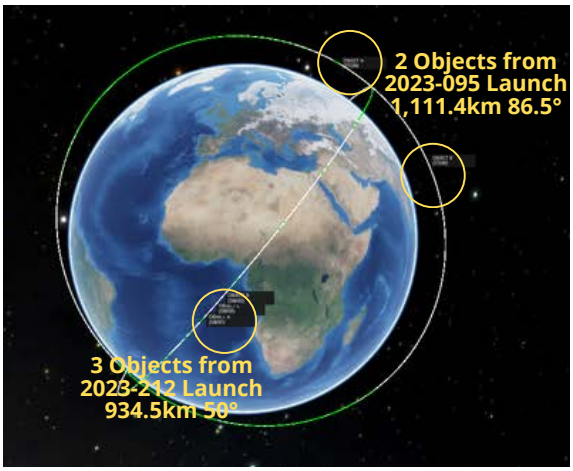
3. 23 Nov 2023: Chuangxing-20 01,02,03 from Xichang, using a LM-2D with SY-3 upper stage (1,104.2 km / 50°)

4. 5 Dec 2023: Unknown satellite from Yellow Sea using a Jielong-3 (913.3 km / 86.5°)

5. 30 Dec 2023: Three WHJS satellites from Jiuquan using a LM-2C with a YS-1 upper stage (936.4 km / 50°)

Patches from Dec (Left) and Jul (Right) (NASA Space Flight)

Big Red Board-Int: Blow Up of Satellite featured after Dec Launch (NASA Space Flight)



YG-41 Settles In & An Overview of China's GEO Imagers

27 Dec: China's Yaogan-41 GEO-based imager has settled into geostationary orbit at 123.3°E longitude. This places the spacecraft, with rumored five meter imagery resolution, just east of Gaofen-13-01. Gaofen-13-1 and Yaogan-41 now bracket the island of Taiwan. Yaogan-41's orbit is inclined 5° while Gaofen-13-1 is only inclined 0.2°. Increasing the Yaogan-41's inclination will periodically bring it closer to Taiwan and other targets, presumably resulting in better imagery resolution. Of course, the higher inclination also takes the satellite further south and negatively impact resolution as well. China launched YG-41 on 15 Dec 2023 using a LM-5 with an extended payload fairing. Launch Video.

- YG-41 is China's 4th optical satellite in GEO. In addition to the previously mentioned Gaofen-13-1, YG-41 joins the civilian Gaofen-4 (2015) and Gaofen-13-2 (2023). China also recently added the world's first SAR imaging satellite in GEO, Ludi Tance 4-01.

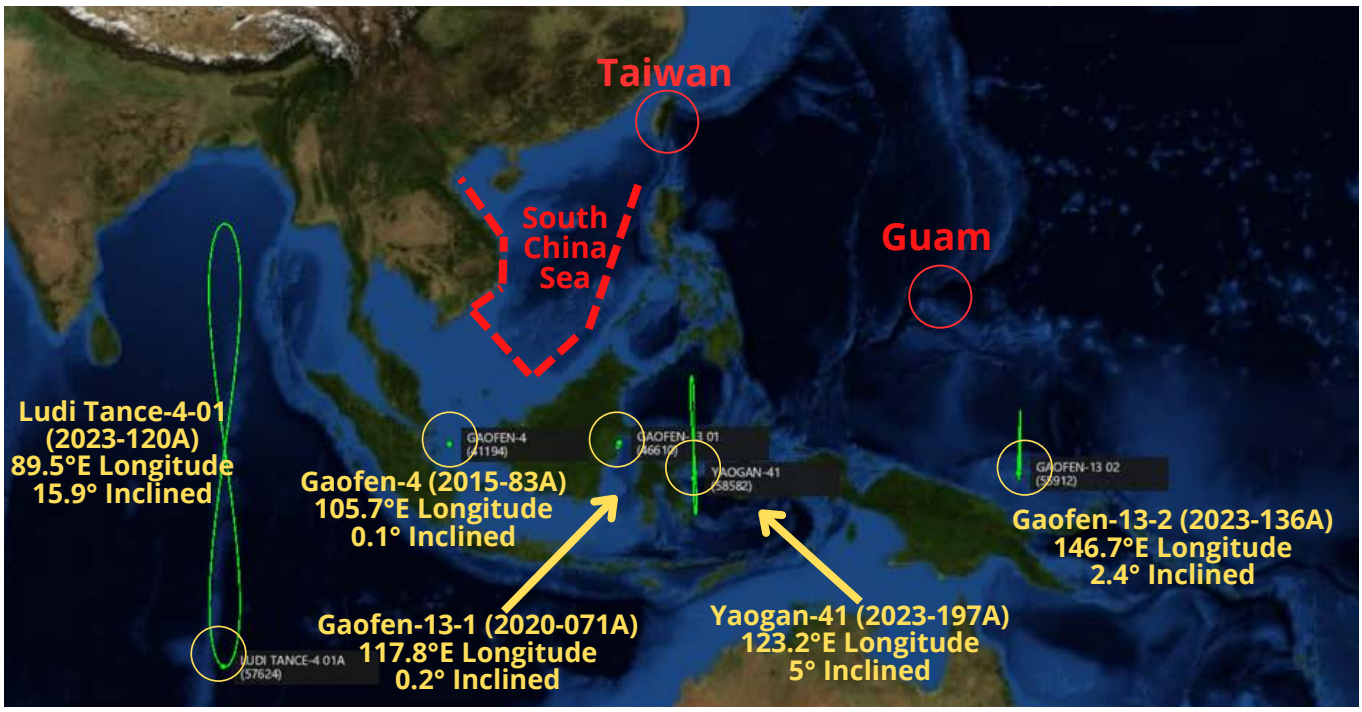
-Chinese scientists have briefed that Gaofen satellites designated 8 or higher are associated with military/national security missions. Analysts believe all Yaogan designated missions have military/national security missions.

- Gaofen-13-1 and 13-2 are believed to be capable of 15m resolution imagery.

- China may be experimenting with different inclination values for its GEO-based imagers. China has placed each successive satellite into a higher inclination… GF-4 at 0.1°, GF-13-1 at 0.2°, GF-13-2 at 2.4° and now YG-41 at 5°.

- All GEO imagers seem to be in orbits to provide constant surveillance of the Western Pacific and areas of potential conflict. GF-13-1 and YG-41 are located on either side of Taiwan and GF-13-02 is 2° east of Guam and <1° east of the Northern Marianas Islands.

- Ludi-Tance-4-01 is the world's only GEO-based synthetic aperture radar (SAR) imager, and located further west than any of the other GEO imaging satellites. It is also highly inclined at 15.9°, likely to provide the relative motion with the Earth's surface to enable it's expected 20m resolution. Though China classified Ludi-Tance-4 as a civilian satellite, it is unknown if the satellite is being used for military/national security missions.



China's Increasing GEO-based Imaging Capabilities and Select Areas of Interest

Highlights: PLA Counterspace Command & Control

11 Dec 2023: Kristin Burke of the China Aerospace Studies Institute released her paper exploring command and control of a variety of China's counterspace weapons. Ms Burke poses two questions about six types of counterspace weapons: 1) Who in the People's Liberation Army (PLA) will operate counterspace weapons in wartime? and 2) Who will task the operators and how will the operators use counterspace weapons in wartime? Interestingly, her research indicates the Strategic Support Force (SSF) will likely not operate all counterspace weapons, with many remaining under the command of the Central Military Commission (CMC) or Theater Command (TC) commanders. Excerpts below. Read the FULL REPORT for yourself!

- The six categories of counterspace weapons are: 1) Direct Ascent Anti-Satellite Missiles (DA ASAT); 2) Directed Energy Counterspace Weapons; 3) Terrestrially Based Satellite Electronic Jammers; 4) Space-based Grappling Counterspace Weapons; 5) Offensive Cyber Counterspace Weapons; and 6) Space Based Electronic Jammers.
- Limited experimental space-based counterspace weapons are probably operated exclusively by the SSF's Space Systems Division (SSD).
- People's Liberation Army (PLA) Theater Command (TC) commanders may have more ease in tasking low-powered directed energy counterspace weapons, and some network-electromagnetic spectrum weapons, than terrestrially-based satellite electronic jammers.
- It seems that while terrestrially-based satellite electronic jammers are prevalent across the TCs, the CMC must pre-approve specific usage, in order to limit spectrum interference within the People's Liberation Army (PLA).
- Reversible satellite laser dazzling and weapons to disable systems using space information, such as microwave weapons and network-electromagnetic spectrum weapons, can probably be readily tasked at the TC level.
- There is limited publicly available information to support that the SSF is the service training with direct-ascent anti-satellite (DA-ASAT) missiles. Rather, there is more information to support those missiles may be operated by other PLA services.
- DA-ASAT missiles potentially could be deployed from many more places than expected: the PLA's primary intention for the missiles is to be a credible deterrent, and only the CMC would cautiously approve their use… there is evidence to indicate that the SSF is not the exclusive owner of those <DA-ASAT> mobile launchers.
- CMC consent for usage of other types of counterspace weapons seems to depend on if the weapons' effects go beyond the theater of use.
- CMC probably directs cyberattacks on satellite ground stations in theater, especially attacks to deliver malware to adversary satellites, because of the beyond-theater effects.
- On-orbit satellite jamming is the one counterspace weapon this report found to be exclusively SSF operated.
- On-orbit grappling is unlikely to be used as a counterspace weapon, until China can miniaturize those systems.
- The PLA seems to be modeling the United States in developing a dedicated unit to conduct defensive and offensive orbital warfare, like Space Force Delta 9, and orbital warfare exercises like Red Skies.

Wartime operation of the People's Liberation Army's (PLA's) counterspace weapons very likely continues to be spread across PLA services, as well as the Strategic Support Force (SSF)… though the SSF does not manage all counterspace weapons.

China: Space War Simulator Unveiled

19 Dec: Chinese military scientists revealed a previously confidential space war-gaming system. According to the developers, the system features a user-friendly design and can simulate and predict the complex process of space combat. This Chinese space war simulator is intended not only for the country's military operations, but also for training and enhancing space commanders and warriors on a much more substantial scale. Watch Australian News Report.

- The National University of Defense Technology in Changsha developed the system, as per a paper published in *National Defence Technology* in October. Authored by a team led by associate professor Zhang Jin, the paper had a section stating the system has already demonstrated its effectiveness in a secret space mission.

Screen Capture from Chinese Space Wargame Application

- Over 400 military cadets created over 70 teams in September for a rigorous, two-month competition. Many participating members claimed that these simulated space battles prepared them for combat, and offered them a first-hand experience of operating weapons that they had only studied in technical documents or textbooks.
- One of the system's most prominent features is that it can make the Earth transparent in the operational interface, allowing users in the Eastern Hemisphere to view situations in the Western Hemisphere.
- The researchers also listed a number of challenges they encountered during development. War in space, they said, offered no real battles as examples. Despite Cold War tensions and recent close calls between China and the U.S. in orbit, no true fight has broken out.
- They also wrote of the struggle to secure weapons data. As closely guarded secrets, any missteps using such data could send military strategy astray.
- To ensure the system would run smoothly even in the most challenging moments of war, researchers considered computational complexity while making sure the calculations could be performed on a mobile military computer.
- To achieve this, the scientists employed parallel computing technologies typically used only in supercomputers, improving computational efficiency and enabling inferior military-grade CPUs to produce simulation results within a short time frame.

The Chinese military is actively developing a new generation of anti-satellite weapons, including high-power microwave emission devices and laser guns. Additionally, the Chinese government plans to launch nearly 13,000 low-Earth orbit internet satellites equipped with military payloads to establish a counter-deterrent against the U.S.

China Year in Space 2023

There were no shortages of "Year in Review" articles this month. Three in particular are worth your time: 1) Adrian Bell, *NASA Spaceflight*, China's 2023: closing out a busy year amidst preparations for lunar missions; 2) *China Space Monitor*, The Year in Chinese Space; and 3) Andrew Jones, *China Space Bulletin*: Review of China space activities in 2023. Highlights below.

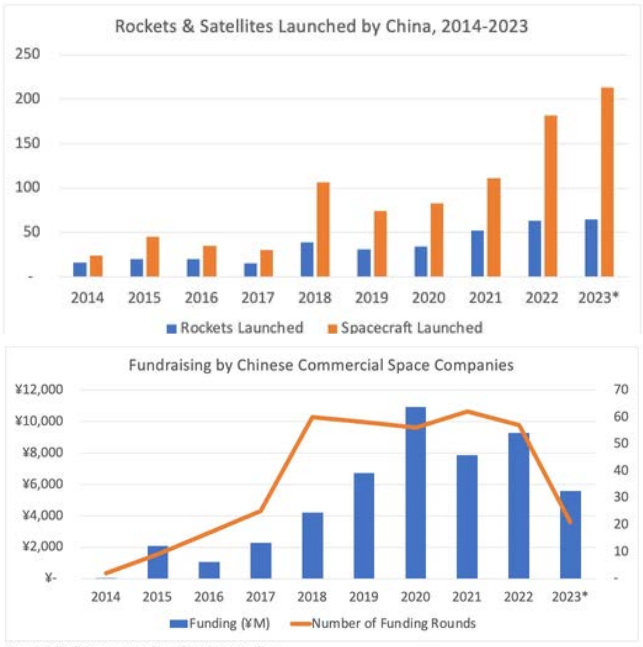
Adrian Bell: China's 2023

- China launched 66 orbital launches in 2023, of which 64 were successes… very close to the country's 2022 performance, which saw 64 orbital launches, of which 62 were successful.
- 46 of these used Long March series boosters. 20 launches were commercial (non-Long March). The LM-2D had the most launches (12).
- Commercial Rising: In 2022, about 83% of launches in China were performed by Long March rockets. In 2023, that number went down to 70%. It was higher in 2021, at 87%.

Workhorse: LM-2D Lifts Off (NASASpaceflight)

***China Space Monitor*: The Year in Chinese Space**

- China sent 213 payloads into orbit in 2023, an increase from 182 in 2022, and 111 in 2021.
- CGSTL was the leader among satellite manufacturers, with 48 satellites launched during the year. However, CASC would take the lead if we combined all of its subsidiaries (CAST and subsidiaries had ~40, while SAST had 24).
- Funding levels dropped by around 40% compared to the peak years of 2020-2022, but remained strong at ~¥5.6B, or ~U.S. $800M. That said, the average rounded funding number was the biggest we've seen in any year, by far.
- 2023 saw the record for most satellites launched on a Chinese rocket, broken twice in one month. First, on 7 June, CAS Space sent 26 satellites into orbit on its ZK-1A from Jiuquan.



Graphs of China Launch/Satellite & Funding (China Space Monitor)

- Just about a week later on 15 June, SAST sent a whopping 41 satellites into orbit on a LM-2D, with all 41 built by Chinese remote sensing company CGSTL for their Jilin-1 constellation.
- In 2024 expect to see initial deployment of China's NGSO broadband constellations, likely via batches of satellites launched for China SatNet, Galaxy Space, or SSST.

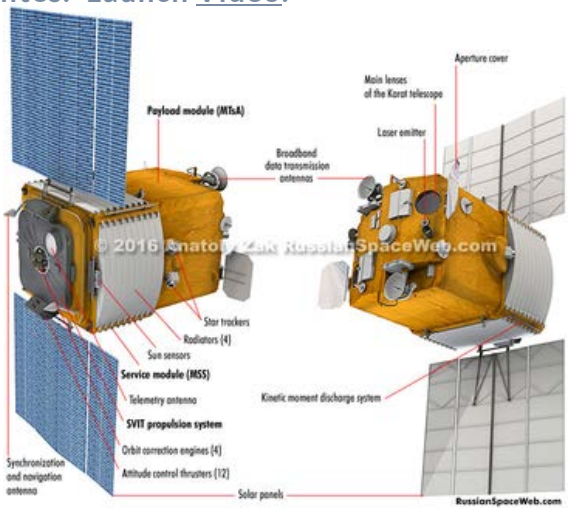
Andrew Jones: Review of China Space Activities in 2023

- This year China committed to a preliminary plan to put two taikonauts on the Moon by 2030. The short period mission would conduct scientific tasks and collect samples.
- In April 2023, Space Pioneer became the first Chinese commercial company to reach orbit with a liquid rocket: the kerosene-liquid oxygen Tianlong-2. Landspace then marked a global first when the second flight of its Zhuque-2 methane-fuelled rocket achieved orbit.

Russia: Launches New Bars-M Imagery Satellite

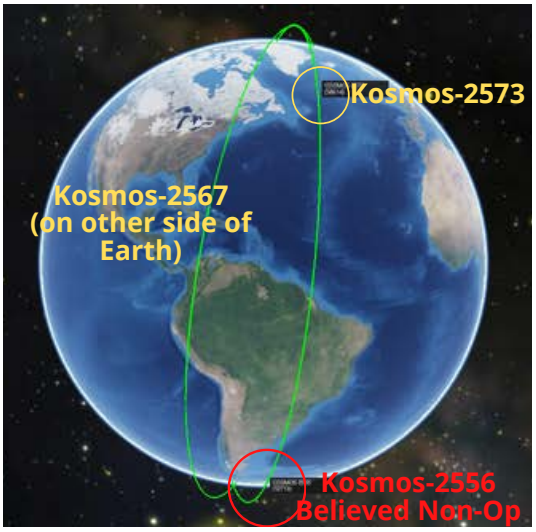
21 Dec: A Soyuz-2-1b (also reportedly a 2-1a) rocket lifted off from Plesetsk, and successfully delivered a spacecraft for the Ministry of Defense. Since been renamed Kosmos-2573, the spacecraft could be the latest of five Bars-M imagery satellites. Launch Video.

- Kosmos-2573 (Bars-M N°5) is in a 338 x 499 km orbit with 97.57° inclination. Interestingly it is co-planar with Kosmos-2556, launched in May 2022.
- The fact that Kosmos-2573 is in the same orbital plane as Kosmos-2556 (Bars-M N°3) is a strong sign that the latter has failed, and that the new satellite serves as a replacement.
- Kosmos-2556 significantly lowered its orbit in July 2022 (from about 560 to 500 km), presumably as a result of a decision to operate these satellites at lower altitudes in order to improve their resolution (possibly related to the war in Ukraine).
- After Kosmos-2556 performed one more (minor) orbit correction in October 2022, it has shown no signs of life since. Notably, Bars-M N°1 and 2 were also short-lived satellites.
- Assuming Kosmos-2556 is non-operational, Kosmos-2573 brings the total number of working Bars-M satellites to two – the other being Kosmos-2567, launched 23 March 2023.
- Originally designed to support cartography, the first Bars-M launched in 2015. The spacecraft's main instrument, inside the MTsA payload module, consists of a dual telescope called OEK (Optical Electronic Complex) Karat. The triple-lens instrument was developed at the LOMO company in St Petersburg, which also built the main Persona reconnaissance satellite's imaging system.
-Bars-M satellites are believed to capable of collecting high-resolution images with a ground resolution around 1 meter.
- Bars-M is one of several series of reconnaissance satellites Russia introduced in recent years, in attempts to fill the gap left by the retirement of its obsolete film-return Kometa and Kobal't-M satellites. Other imaging satellites included the now-ended Persona series, and the smaller EMKA.



Bars-M Rendering (Russianspaceweb.com)

Kosmos-2556 Non-Maneuvering Since Oct 2022 (celestrak.org)

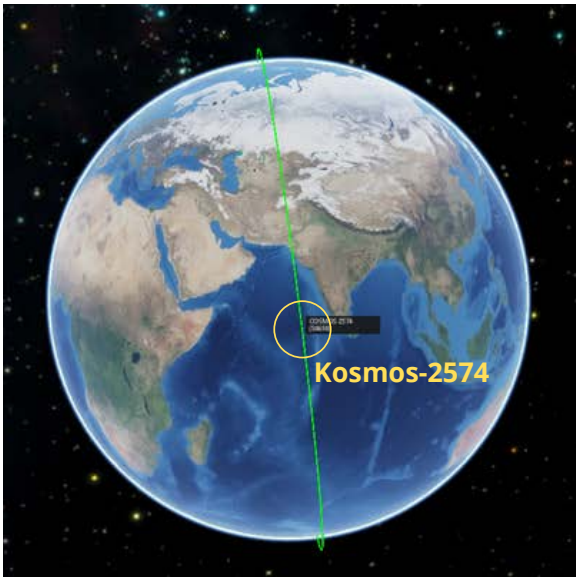


Bars-M Constellation (spaceaware.io)

Russia: Kosmos-2574 Launched

27 Dec: Russia launched a Soyuz 2.1v from Plesetsk carrying a suspected Razbeg imagery satellite. Some rumors suggest the satellite might have been a Nevilir inspection satellite, however the launch did not have a Volga upper stage, nor was it placed into an orbit near another satellite. Current prevailing opinions are that Kosmos-2574 is a small imagery satellite capable of 0.9 m ground resolution. Launch Video.

- Kosmos-2574 was launched into a 338 x 498 km Sun synchronous orbit, with an inclination of 97.6°.
- Russia released no information regarding the satellite or its mission.
- Analysts believe Kosmos-2574 is an EO MKA / Razbeg imagery satellite. There is some confusion whether Kosmos-2574 is an EO MKA or Razbeg satellite, nor is it clear the distinctions between the two satellite types.
- Kosmos-2574 is at a higher altitude than previous EO MKA satellites (Kosmos-2551, 2555, 2560 and 2568).
- Kosmos-2568 is the only EO-MKA satellite of four intended to remain on orbit more than a few weeks. It is currently in a 329 x 345 km ellipse.
- Other than Kosmos-2568, Russia has only one other active satellite operating at lower altitudes than Kosmos-2574: Kosmos-2572 (launched 25 Nov 2023).



Kosmos-2574 Orbit (Spaceaware.io)

- Kosmos-2572 is believed to be the new Razdan imagery satellite.
- EO MKA / Razbeg imagery satellites are believed to be a small optical reconnaissance satellites (~150 kg) built by VNIIEM. Expected ground resolution is 0.9m.

Paper: Anti-satellite Weapon Tests to Disrupt Large Satellite Constellations

28 Dec: *Nature Astronomy* published a paper by Aaron Boley and Michael Byers, from the University of British Columbia, which discusses the applicability of conducting a debris-generating kinetic Anti-Satellite (ASAT) Test to disrupt megaconstellation operations. Specifically, the authors modeled Russian Cosmos-1408 DA-ASAT test effects, if it had been conducted at SpaceX Starlink's primary operating altitude (550 km). Read Full Article.

- Russia hit Cosmos 1408 with a ground-based missile at 480 km and produced 1,500 pieces of trackable debris that threatened the International Space Station (ISS) and China's Tiangong space station.
- Direct-ascent ASAT tests use a missile launched from the ground, sea or air to destroy a satellite or rocket body owned by the testing state, using the tremendous kinetic energy of the collision.
- The debris from the 2021 test created complications for satellites at higher altitudes, including SpaceX's Starlink 'megaconstellation.' According to SpaceX, over 1,700 of the 6,873 collision-avoidance maneuvers performed by its satellites from 1 December 2021 to 31 May 2022 were due to Cosmos 1408 debris.
- This outcome raises the possibility that a state may conduct a 'test,' with the intent of disrupting other countries' space operations
- For Starlink, SpaceX reports using a collision probability threshold of 1 in 100,000 for conducting collision-avoidance maneuvers.
- **If the 2021 target satellite had been closer to the Starlink 550 km shell, instead of one at an altitude of 480 km… the authors estimate Starlink maneuvers would increase from 24/day to 240/day – an order-of-magnitude more conjunctions. Projecting over 151 days, the expected number of conjunctions would be 36,000.**

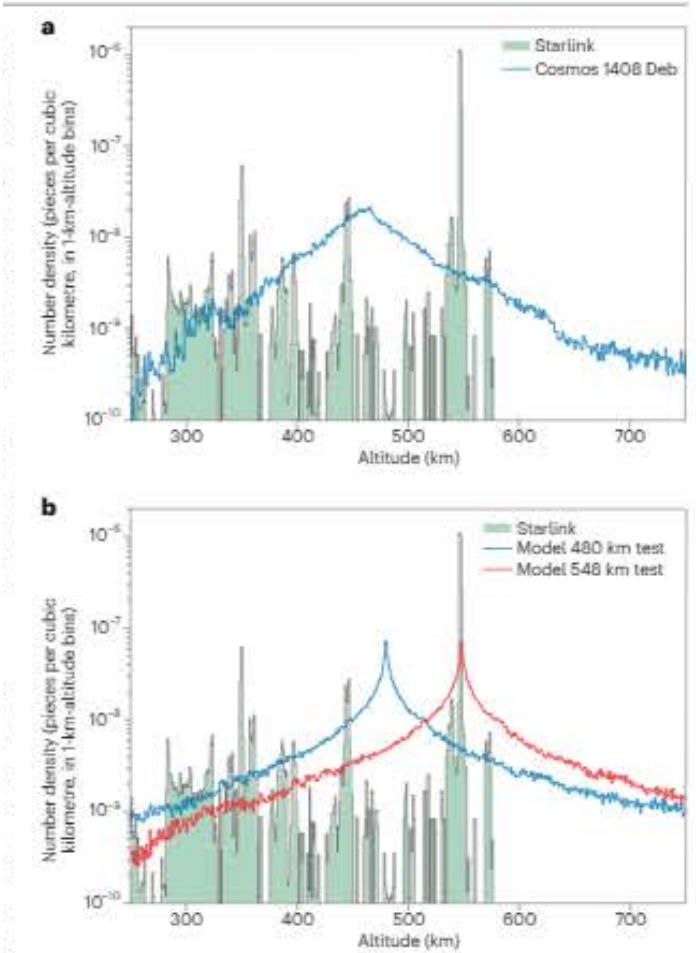


Fig. 2 | ASAT debris overlapping Starlink satellites, 27 Jan 2022. a, The density distribution for almost 1,900 Starlink satellites (green) and Cosmos 1408 debris (blue). **b**, Similar to panel **a**, but for two hypothetical 2021 ASAT test analogues at altitudes of 480 and 548 kilometres. We note that the actual debris profile has been shaped by some orbital decay, but the model profiles have not. Data are taken from US Space Command.

Instead of being designed to physically damage satellites, the creation of fragments through a carefully crafted ASAT weapon test would disrupt a megaconstellation by requiring a very much larger number of collision-avoidance maneuvers. This would lead to increased fuel use, shorter satellite lifetimes, and possibly degradation of services. A high frequency of maneuvers also brings the possibility of errors or maneuver conflicts, and with this a much greater likelihood of collisions.

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NAICS:
611512 (Flight Training)
611519 (Other Technical Training and Trade Schools)

DDTC/ITAR Registered

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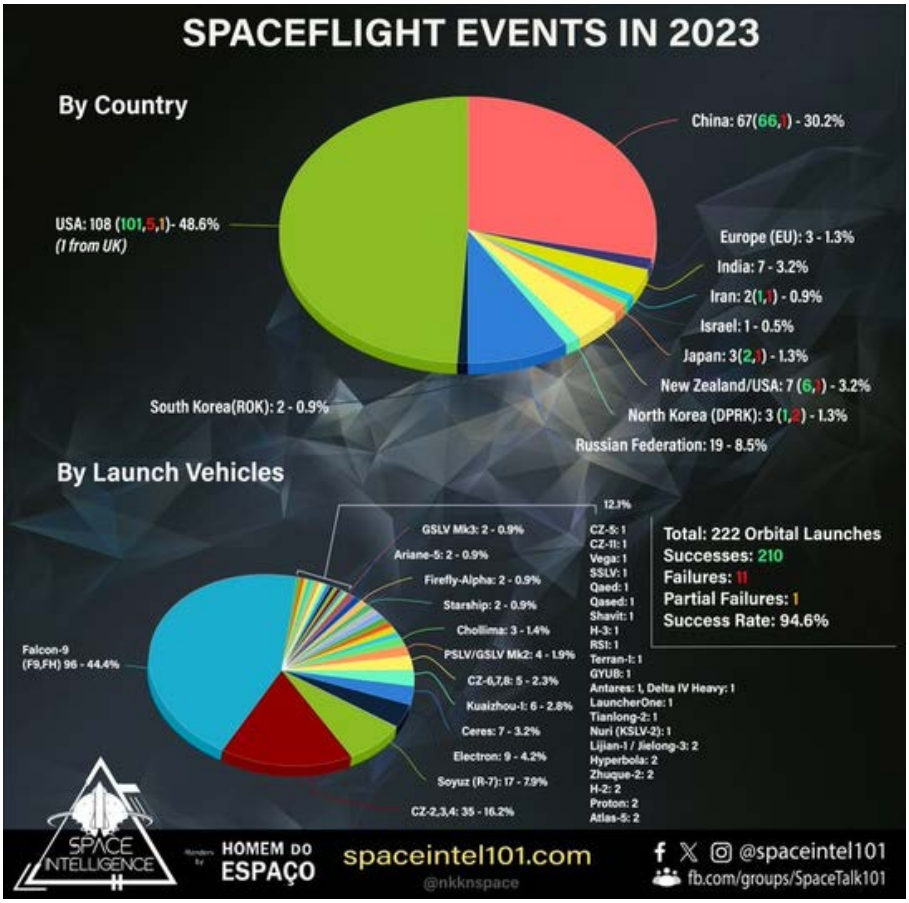
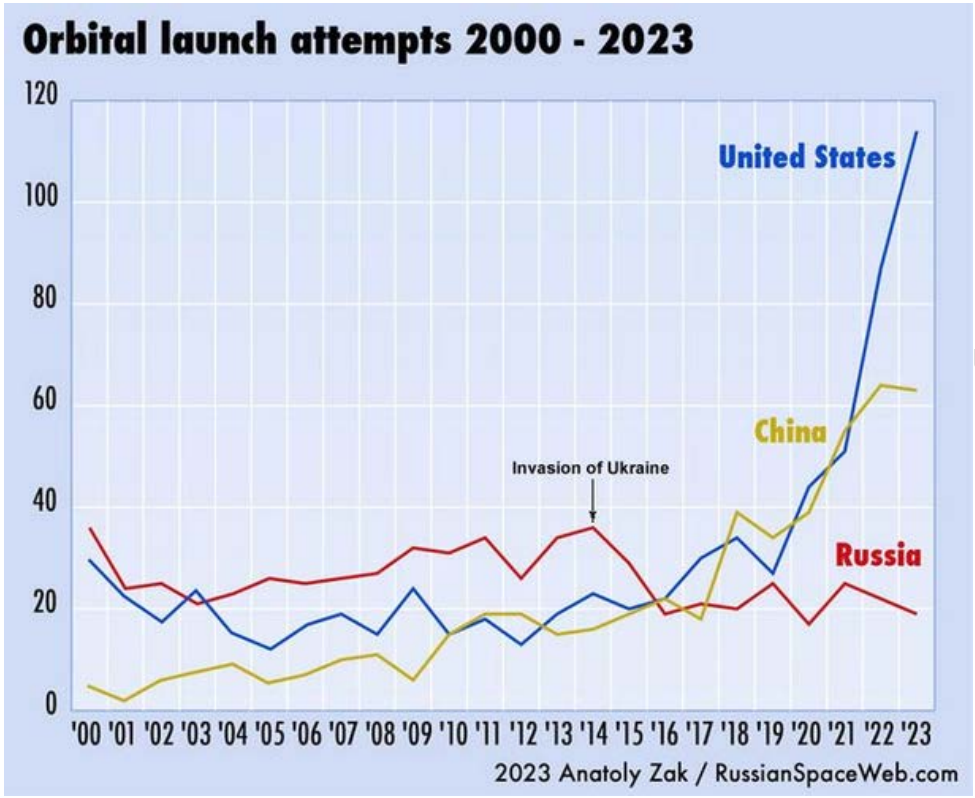
Pics o' the week!

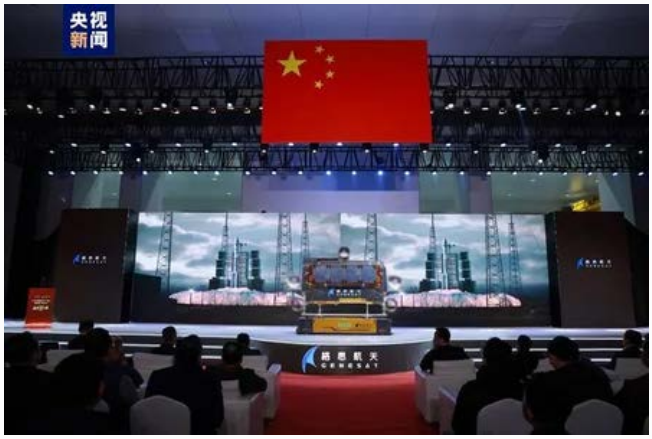
Year in Review (@spaceintel101 via X)





SpaceX alone was responsible for 98 of the 109 launch attempts made by the US in 2023, and 1,937 of the 2,234 US satellites successfully orbited. (@BreakingDefense) Graph From (Anatoly Zak via X)

2023 SAST Launch Patches

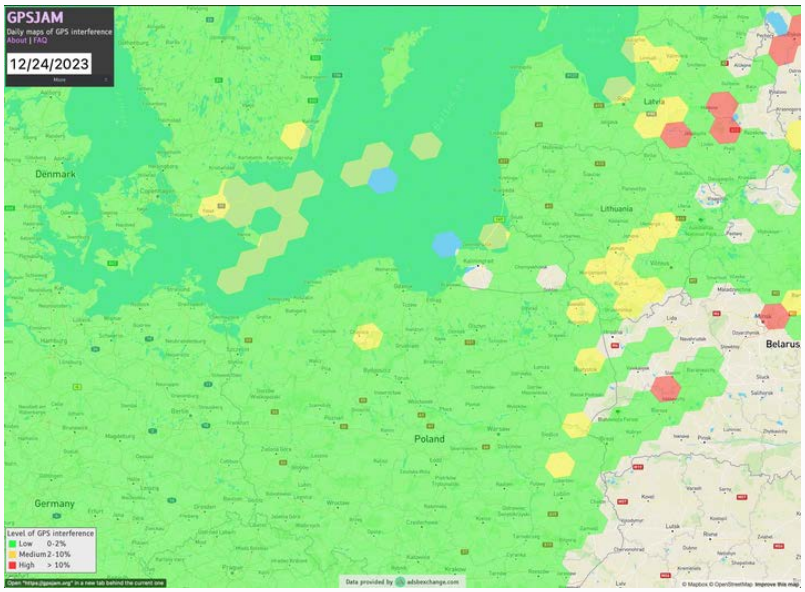


- **1st "G60" Internet Satellite On Display.**
- **108 satellites are planned to be launched in 2024.**
- **Shanghai government is encouraging local rocket & satellite makers to produce 50 rockets and 600 satellites annually by 2025.**

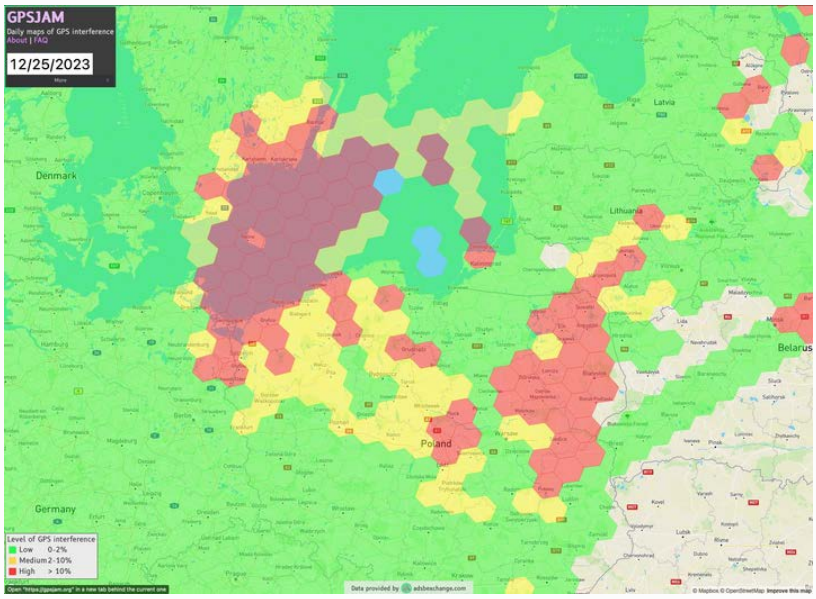
(@raz_liu via X)

- **No. 1 launch pad at Wenchang complete.**
- **It is the first commercial launch site at Wenchang.**
- **Dedicated to Long March-8, a medium-sized rocket mainly for low-Earth & Sun-synchronous orbits.**

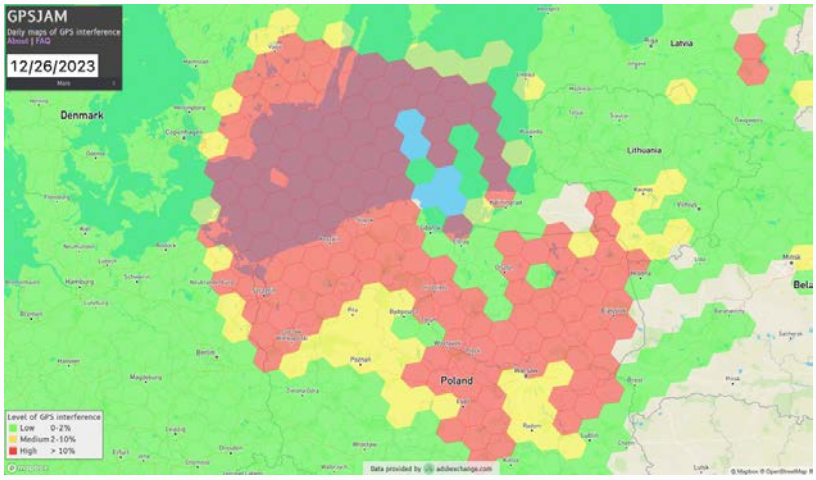
(@wulei2020 via X)



GPS Interference Western Europe/Baltic 24 Dec



GPS Interference Western Europe/Baltic 25 Dec



GPS Interference Western Europe/Baltic 26 Dec

Image by Valerio Minato (@ValerioMinato) via X

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#WeKnowISR

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WHO WE ARE

Integrity ISR employs a diverse group of former military service members, national security experts, and academic professionals to deliver innovative C4ISR, Space & Cyber solutions.

WHAT WE DO

Integrity ISR offers a wide-range of services for multi-domain C4ISR, Space & Cyber strategy, training and operations - enabling operations in any domain under any conditions, from permissive to highly contested and denied environments.

WHY WE DO IT

Our number one priority is to strengthen US national security - increasing US readiness and lethality, building C4ISR, Space & Cyber capabilities for the US and our allies, and fostering increased interoperability for tomorrow's coalition.

WE ARE HIRING!

https://integrityisr.com/careers/

OPEN POSITIONS

SPACE CYBER INSTRUCTOR (VANDENBERG SFB CA)

SPACE ISR INSTRUCTOR (VANDENBERG SFB CA)

INSTRUCTOR FOR SPACE ACQUISITIONS (REMOTE)

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