4 JUNE 2023

THE FINAL FRONTIER FLASH

Developments & Analysis of the Space Domain

ISR UNIVERSITY

SFA SPACE FORCE ASSOCIATION

In This Issue

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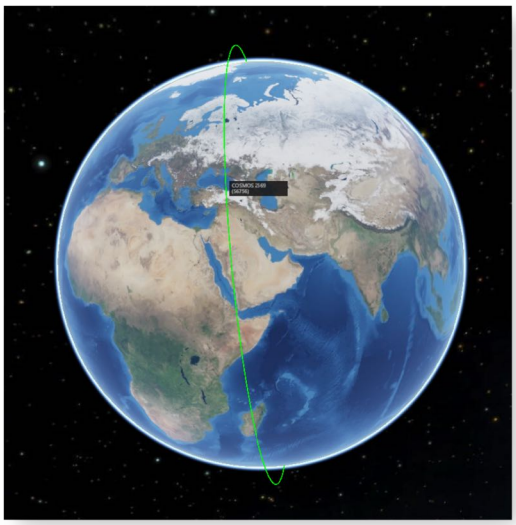
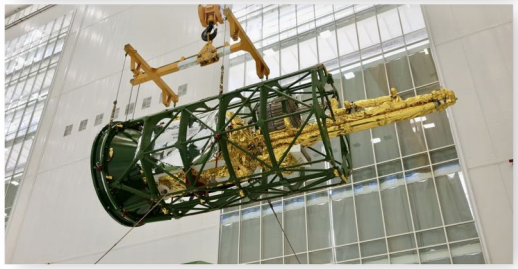
Catalog

Russia Launches New Imaging Satellite

26 May 2023: Russia launched a new SAR imaging satellite, the Kondor-FKA n°1,from Vostochny Cosmodrome. The Kondor satellites are a series of Earth observation satellites providing reconnaissance services for the Russian military. Launch Video & Soyuz Stacking Video.

- Kondor-FKA n°1 has been given the name Cosmos 2569 and is in a 508x506km sun-synchronous orbit.
- The Kondor satellites feature an S-band synthetic aperture radar (SAR), conducting both continuous swath surveys and detailed spot surveys of Earth's surface. The width of the SAR's swath is 10km with a ground resolution of 1-2m in spotlight mode, 1-3m in strip-map mode, and 5-30m while in ScanSAR mode.
- Kondor-FKA will assist Russia in its war against Ukraine. It makes two passes over Ukraine each day and can make radar images of "Ukrainian military objects" with a resolution of 1m.
- Officially, Kondor-FKA is a civilian satellite ordered by Roskosmos, but in the current circumstances it may well become a dual-purpose satellite.
- The only other positively identified Russian radar satellite currently in orbit is Kosmos-2550 (Pion-NKS), but this is mainly intended to provide targeting data for anti-ship missiles. However, it is quite likely that Kosmos-2553 (Neitron) is also a military radar satellite. Like Kondor-FKA, this is a product of NPO Mashinostroyeniya and appears to use the Kondor bus. In fact, it may have been used to test various new systems flown aboard Kondor-FKA. Kosmos-2553 does circle the globe in a significantly higher orbit (about 2000 km) inclined 67° to the equator.





Kondor in Protective Cage & attached to Briz Upper Stage

**Rendering of Kondor Deployment…
Upper Stage Remains Attached to Briz Upper Stage**

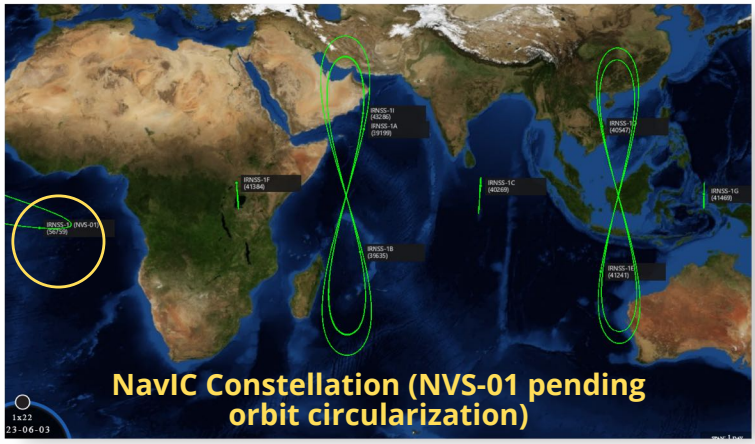
Recent Kondor Briefing Slide

3rd Stage Cut-Off

India Launches Next Gen Navigation Satellite

28 May 2023: India launched a NVS-01 navigation satellite using a Geosynchronous Satellite Launch Vehicle (GSLV) Mk.11 rocket from the Satish Dhawan Space Centre. NVS-01 is the first of India's second-generation NavIC satellites and is equipped with new Indian-developed atomic clocks. Launch Video. Satellite Deployment Video.

- The Navigation with Indian Constellation (NavIC), system is a regional satellite navigation network developed by the Indian Space Research Organisation (ISRO). Also known as the Indian Regional Navigation Satellite System (IRNSS), the system's first generation consists of seven satellites in geosynchronous orbit – although a total of nine spacecraft have been launched, including replacements.



- IRNSS-1A, the first satellite in the series, was launched in Jul 2013, with the constellation reaching its full complement following the launch of IRNSS-1G in Apr 2016. After three years in orbit, the atomic clocks aboard IRNSS-1A began to develop faults, and IRNSS-1H was launched as a replacement in Augt 2017. This did not reach orbit after the payload fairing of its carrier rocket failed to separate, so IRNSS-1I was deployed instead in Apr 2018, becoming the final first-generation IRNSS satellite to launch.

- ISRO has confirmed the failure of several other clocks across other satellites in the fleet. ISRO's annual report for 2020-21 noted that the IRNSS-1G satellite had also been moved to a secondary role, but did not identify the reason for this. NVS-01 is expected to take IRNSS-1G's slot in the constellation.

-Accurate timekeeping provided by atomic clocks is vital to operating navigation satellites, as the signals they broadcast contain timestamps. Receivers use these timestamps, and the knowledge that radio signals propagate at the speed of light, to calculate distance to the satellites and triangulate their position based on the signals and relative positions of multiple satellites.

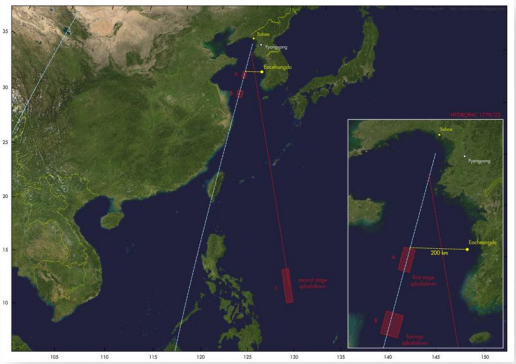
-NVS-01 is also over 900kg heavier than the first-generation satellites and incorporates other enhancements to expand the capabilities of the NavIC constellation. These include broadcast of a new L1 signal, in addition to the L5 and S-band signals broadcast by the existing satellites, which will improve interoperability with other satellite navigation systems such as the US Global Positioning System (GPS) network.

North Korea Attempts Satellite Launch

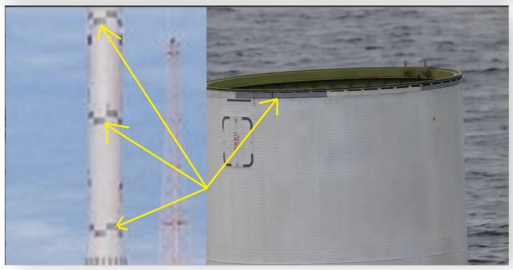
30 May 2023: North Korea attempted its first satellite launch attempt in 7 years, with a Chollima-1 rocket failing to deploy the Malligyong-1 satellite. The rocket lifted off from the Sohae Satellite Launching Ground and appears to have suffered an anomaly around the time of first stage separation and did not achieve its planned orbit. Debris from the launch fell into the sea off the coast of South Korea, where it has been recovered by South Korean forces.

- Malligyong-1 was believed to be an electro-optical imaging spacecraft. The satellite's name translates as "great mirror" or "telescope".
- North Korea's National Aerospace Development Administration (NADA) claimed that Malligyong-1 would be able to image the Earth at resolutions of up to 20m using a monochromatic camera and the spacecraft would be equipped with multispectral imaging and video transmission system. The satellite was supposed to orbit at an altitude of 500km.

- The rocket splashed 200km from Eocheong into a location consistent with the planned stage 1 impact area. The resulting debris fell into the Yellow Sea. It appears the Chollima-1 SLV first stage may be powered by dual nozzle RD-250 derived liquid fuel engine as fitted to N Korea's Hwasong-15 ICBM.
- Hazard areas announced ahead of the launch indicated a high-inclination orbit was being targeted, with the rocket initially flying south-southwest from its launch site before making a dog-leg maneuver to the south-southeast after the separation of the first stage. This trajectory would have resulted in an orbital inclination of about 76° – although a further dogleg during third-stage flight could have increased the inclination for a more polar or sun-synchronous orbit.



-Although the timing is almost certainly a coincidence, Wednesday's launch is the second from the Korean peninsula in less than a week with South Korea launching one of its Nuri rockets last Thursday.
- North Korea's rocket and the satellite are brand-new, suggesting their capacity and other technical details are shrouded in mystery.

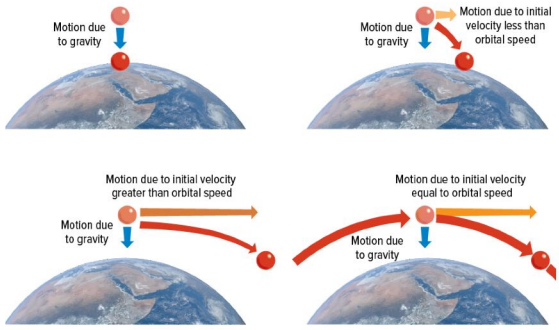


- Following the failure, North Korea stated their intent for another launch as soon as possible, once an investigation has been completed and any necessary tests completed.
- North Korea has been developing satellite reconnaissance capabilities for some time, with hardware being test-flown during missile tests last year. In Mar 2022 the country's leader, Kim Jong Un, toured the Sohae launch site. He also recently toured the satellite manufacturing facility. Video

Report: Large Constellations of Low-Altitude Satellites

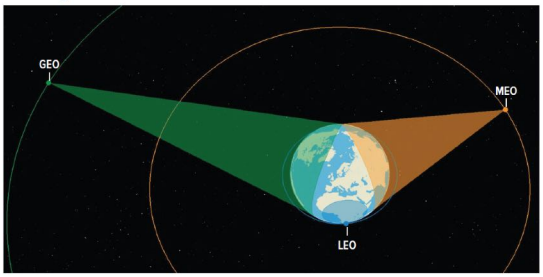
May 2023: The US Congressional Budget Office (CBO) published a primer on the increasing use of LEO satellite constellations. Great article for those new to space operations as well as a look at the capability and economic factors driving pLEO constellation development/deployment. I found the primer to be a great info-graphic resource…some favorites below (all are hyperlinks).

Effects of Altitude and Initial Velocity on a Satellite's Trajectory



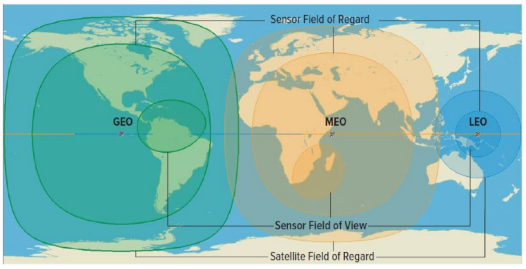
Gravity always pulls objects toward the Earth (top left panel). An object's initial velocity across the surface of the Earth determines what happens in addition to its falling. If the velocity is too low, the object will move across the surface but still hit the Earth (top right panel). If the velocity is too high, it will miss the Earth and travel into space (bottom left panel). If the velocity is just right, it will trace a circle around the Earth and return to the same original spot, a path known as an orbit (bottom right panel).

Field of Regard for Satellites in Various Orbits



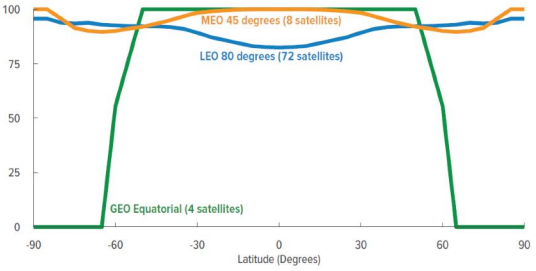
This illustration represents a three-dimensional depiction of the viewing area (field of regard) of satellites in LEO (1,000 km), MEO (18,000 km), and GEO (35,786 km). The coverage area represented here takes into account the Earth's geometry but not other variables, such as any sensor-related limitations on viewing angle.

Fields of View and Fields of Regard for Sensors and Satellites in Various Orbits



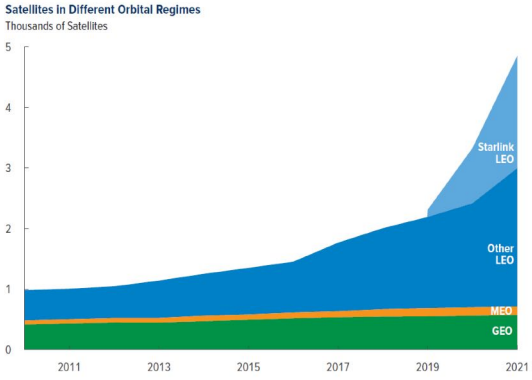
If the viewing angle must be at least 20 degrees above the horizon, the sensor's field of regard (intermediate circles) is smaller than the satellite's field of regard (outer circles). A camera with a very wide field of view might be able to view everywhere within its field of regard, but most sensors look at an area that is much smaller than their field of regard at any given moment (smallest oval).

Coverage of Three Illustrative Constellations



The GEO constellation provides full coverage up to about 50 degrees latitude, but none near the poles; the MEO constellation provides full coverage except for a band around 60 degrees latitude; and the LEO constellation provides about 95 percent coverage at the higher latitudes but dips to about 80 percent nearer the equator.

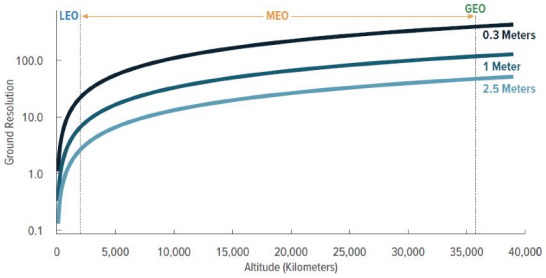
Satellites in Different Orbital Regimes



The number of satellites in all three orbital regimes grew slowly but consistently through the mid-2010s. Starting around 2018, the number of satellites operating in LEO began to grow sharply.

That growth has been spurred by so-called megaconstellations built by commercial firms. SpaceX has led the way with its Starlink constellation of communications satellites, which accounted for more than half of the launches of LEO satellites in 2020 and 2021.

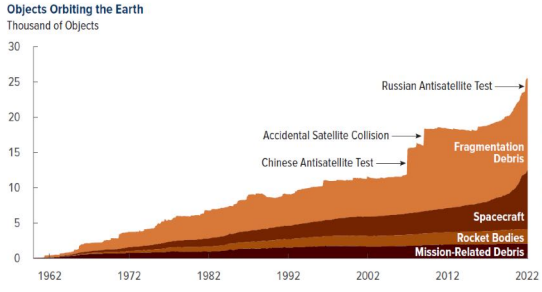
Diffraction-Limited Resolution for Various Aperture Sizes



The larger the telescope, the better (smaller) the resolution. The Hubble Space Telescope has an aperture of about 2.5 m.

The diffraction limits on ground resolution are shown for a wavelength of 500 nanometers (corresponding to light with a blue-green color) near the center of the visible light spectrum, using three different telescope apertures.

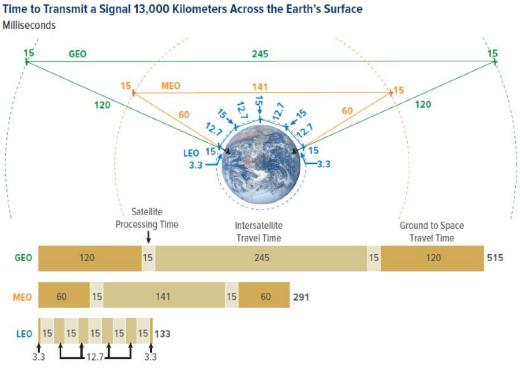
Objects Orbiting the Earth



The number of orbital debris objects has grown substantially, particularly since 2005, in part because of specific events.

The total number of objects in orbit—debris and spacecraft—has roughly doubled in the past 15 years. The vast majority of that increase has been at LEO altitudes.

Time to Transmit a Signal 13,000 Kilometers Across the Earth's Surface



The transit time for a message to travel from one location on the Earth's surface to another location using a satellite constellation varies by the constellation's altitude.

Satellites in lower altitudes communicate with users on the ground more quickly but require more satellites in the chain. The distance between each satellite is shorter for lower altitude orbits, however. Overall, the total transit time for LEO is about half that of MEO and a quarter that of GEO.

On Orbit Updates: Tianhui 2-02A & 02B

- China maneuvered Tianhui 2-02A & 02B, two Synthetic Aperture Radar (SAR) imaging satellites, to within 1km of one another.

-Orbital graphs indicate Tianhui 2-02A maneuvered into proximity with 2-02B, after making multiple altitude changes whereas the SMA for 2-02B remained unchanged.

- Tianhui 2-02A and 2-02B launched on 18 Aug 2021 on a Long March 4B from Taiyuan.

- The Tianhui 2 ("Sky drawing") series are a quasi-secretive group of Earth observation satellites designed to monitor Earth's surface. They are constructed by Dong Feng Hong and operated by the People's Liberation Army.

- The TH-2 satellite system is China's first microwave surveying satellite system based on synthetic aperture radar technology.

- The satellites are in a sun synchronous orbit as is typical for imaging satellites.

- This activity is rare for these types of satellites.

- One possible explanation is the two satellites will work cooperatively. As an example, China recently launched 4 SAR satellites that will fly in formation.

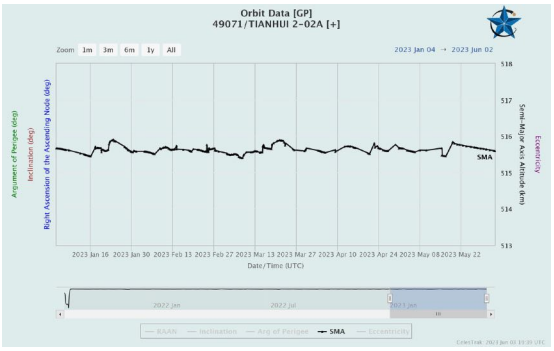
The PIESAT (also known as Hongtu-1 01A-D) spacecraft are X-band synthetic-aperture radar satellites with a resolution of 0.5-5m.

-The four PIESAT satellites form a single module. The module consists of one main satellite and three sub-satellites oriented around the main module. The main satellite will act as the transmitter, while the three passive satellites are the receivers.

-As of 3 Jun the PIESAT satellites have not maneuvered into formation.

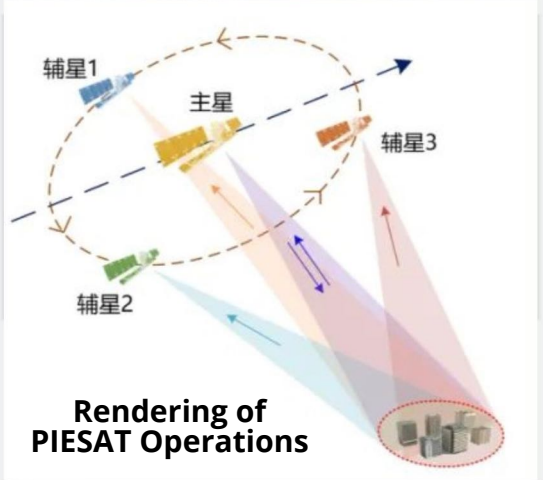
-Other potential rationale is a secondary mission or using one satellite to image the other (unknown if this is a possibility with a SAR imager).

-Based on 3 Jun orbital parameters, the satellites will remain .5km from one another with a relative velocity of .001km/sec for the next several days.

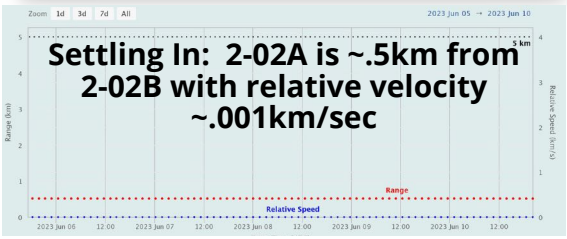


Multiple SMA Changes for TN 2-02A

Steady-as-she-goes: No SMA Changes for TN 2-02B



Rendering of PIESAT Operations

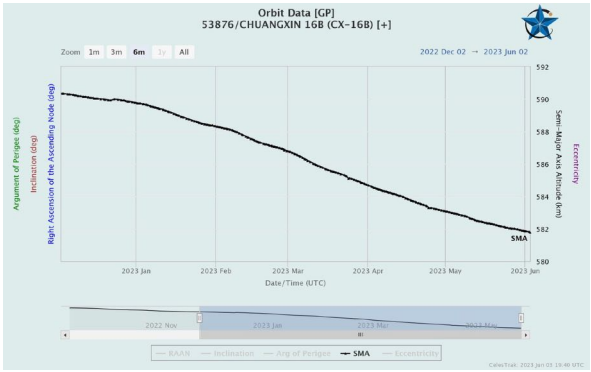


Settling In: 2-02A is ~.5km from 2-02B with relative velocity ~.001km/sec

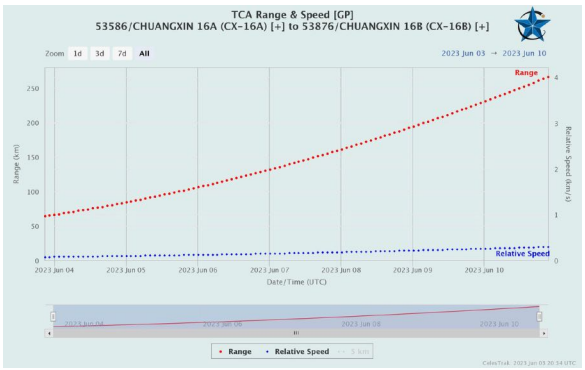
On Orbit Updates: Chuangxin 16A & 16B

- China maneuvered its experimental Chuangxin 16A & 16B satellites to rendezvous with one another in late-May to early-Jun.
- Based on 27 May orbital parameters, the satellites were to close within .002km and relative speed .002km/sec.
-On/about 30 May, Chuangxin 16A altered its SMA slightly (~.1km) and, as a result, the two satellites began separating.
-As of 3 Jun the two satellites are 62km apart with a relative velocity of .07km/sec.
- China launched Chuangxin 16A & 16B on 23 Aug 2022 China, using a Kuaizhou-1A from Xichang. Both spacecraft were developed by the Chinese Academy of Sciences (CAS). Launch Video.
- The spacecraft will reportedly be used for verification of new technologies. Few details were publicly released on the Chuangxin-16 and there was some confusion over the number of satellites carried to orbit (either 1 or 2).
- The Chuangxin (translated as "innovation") payload is meant for technology research...one possible demonstration would be automated undocking, rendezvous, and re-docking of these two satellites.
- Both satellites are in a 29° inclined orbit and it appears that Chuangxin-16A has routinely decreased its SMA since Jan 2023. Chuangxin-16B does not appear to have changed its SMA or other parameters since being placed into orbit in Aug 2022.
-Conducting proximity operations between two technical verification satellites, while unusual, is not unexpected and appears to be consistent with stated mission purposes (vague as they were).

CG-16A Step-Down SMA Pattern



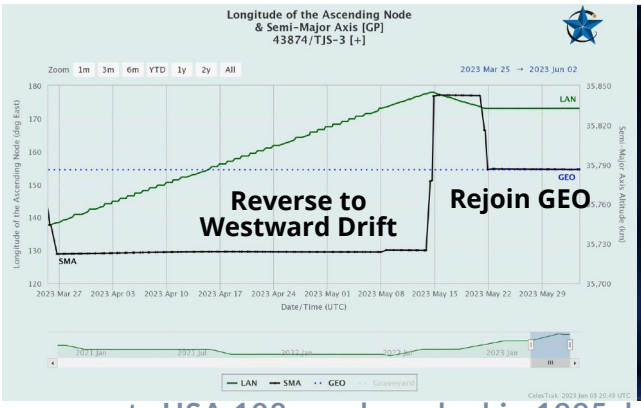
CG-16B Minimal SMA Maneuvering



Projected Increasing Separation

On Orbit Updates: TJS-3

Between 13-21 May 2023, TJS-3 altered its SMA to reverse its its eastward drift. TJS-3 remained ~56kms above GEO and drifted westward from 177.9° to 173.0°E. On 20-21 May, TJS-3 decreased its SMA to rejoin the GEO belt and has remained at 173.0°E.



TJS-3 may be making a return visit to USA 108, a UHF Follow On military comsat. USA 108 was launched in 1995, but appears to be maintaining its orbit.

On Orbit Updates: On the Road Again, SJ-20 heads East

-Between 25-26 May 2023, China's SJ-20, believed to be an experimental communications satellite, decreased its orbit ~55km, initiating an eastward drift.

- China launched the SJ-20 on 27 Dec 2019 on the massive CZ-5 launch vehicle. SJ-20 is China's largest communications satellite (8,000+kg) and uses the DFH-5 bus.

- In Aug 2020, USA 271, one of the US Geosynchronous Space Situational Awareness Program (GSAPP) satellites, approached SJ-20. However, the Chinese clearly detected the US satellite and rapidly moved SJ-20 away. Watch Video.

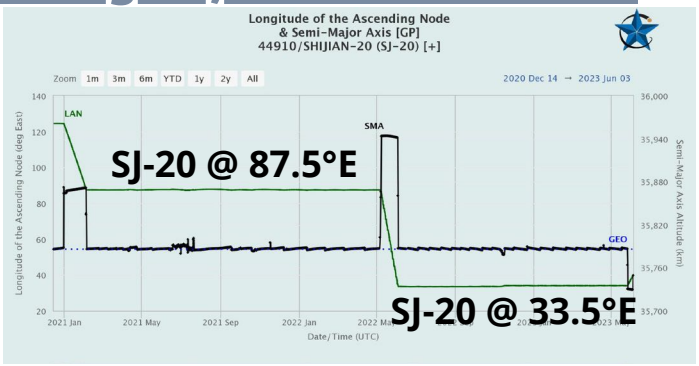
-Almost exactly one year ago, SJ-20 relocated from 87.5°E to China's ITU reserved 33.5°E.

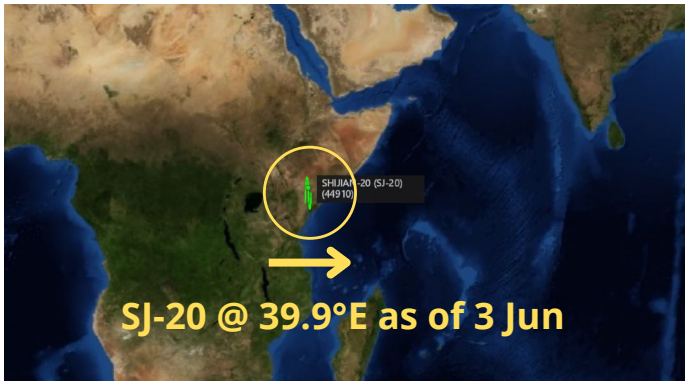
- Interestingly 33.5°E is due south of Ukraine, between Kyiv and Kharkiv.

-Given the experimental nature of SJ-20, it is unlikely it was providing any communications support to any Russian combatants.

-China may have stationed SJ-20 over an active conflict to test other capabilities.

-SJ-20 subsequently raised its orbit ~20km on 3 Jun, slowing its drift. 3 Jun 2023 observations placed SJ-20 at 39.9°E.





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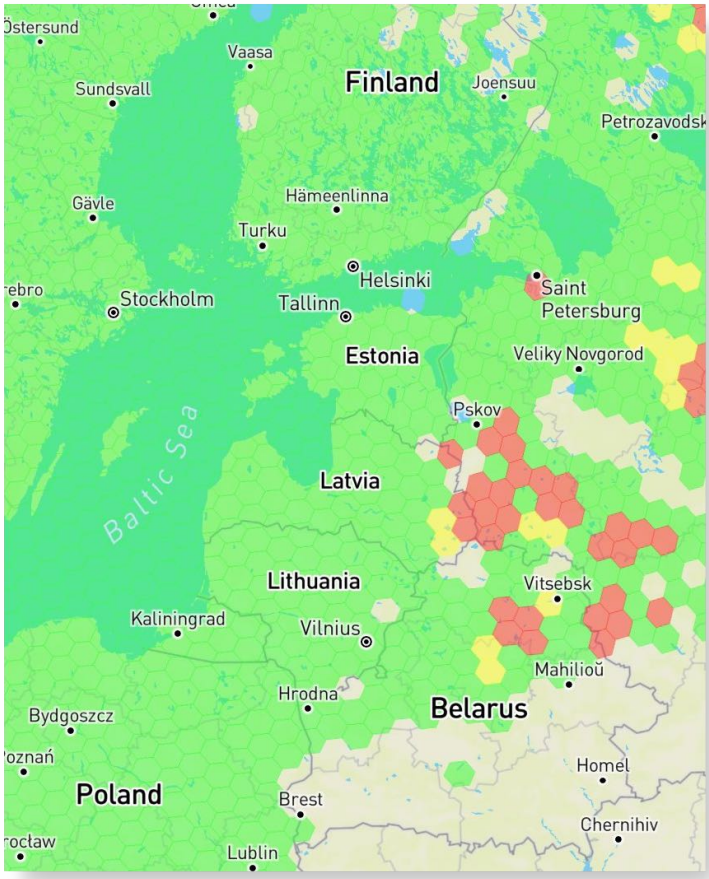
Pics o' the week!

Gone Fishing: South Korean military released photos of the presumed debris of the North Korean satellite rocket



Russian GPS jamming - now all around the border with Russia/Latvia in Pskov Oblast. [29 May]. First time such extensive jamming seen near the border and likely in response to recent drone attacks targeting Moscow.

Roscosmos postponed the launch of Russia's luar lander, Luna25, from July to August 2023

China Launches Shenzhou-16, briefly putting 6 Taikonauts in orbit (including first civilian)

That's a Hard No: Russian space and rocket engineers are being recruited to join a new Russian army battalion called Uranus to fight in Ukraine. Advertisements published by Russia's space agency, Roscosmos, promise that it will "educate you with a strong spirit, will and body."

Low Confidence: 1st partial photo of China's Spaceplane

Spain becomes 25th Nation to Sign Artemis Accords

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