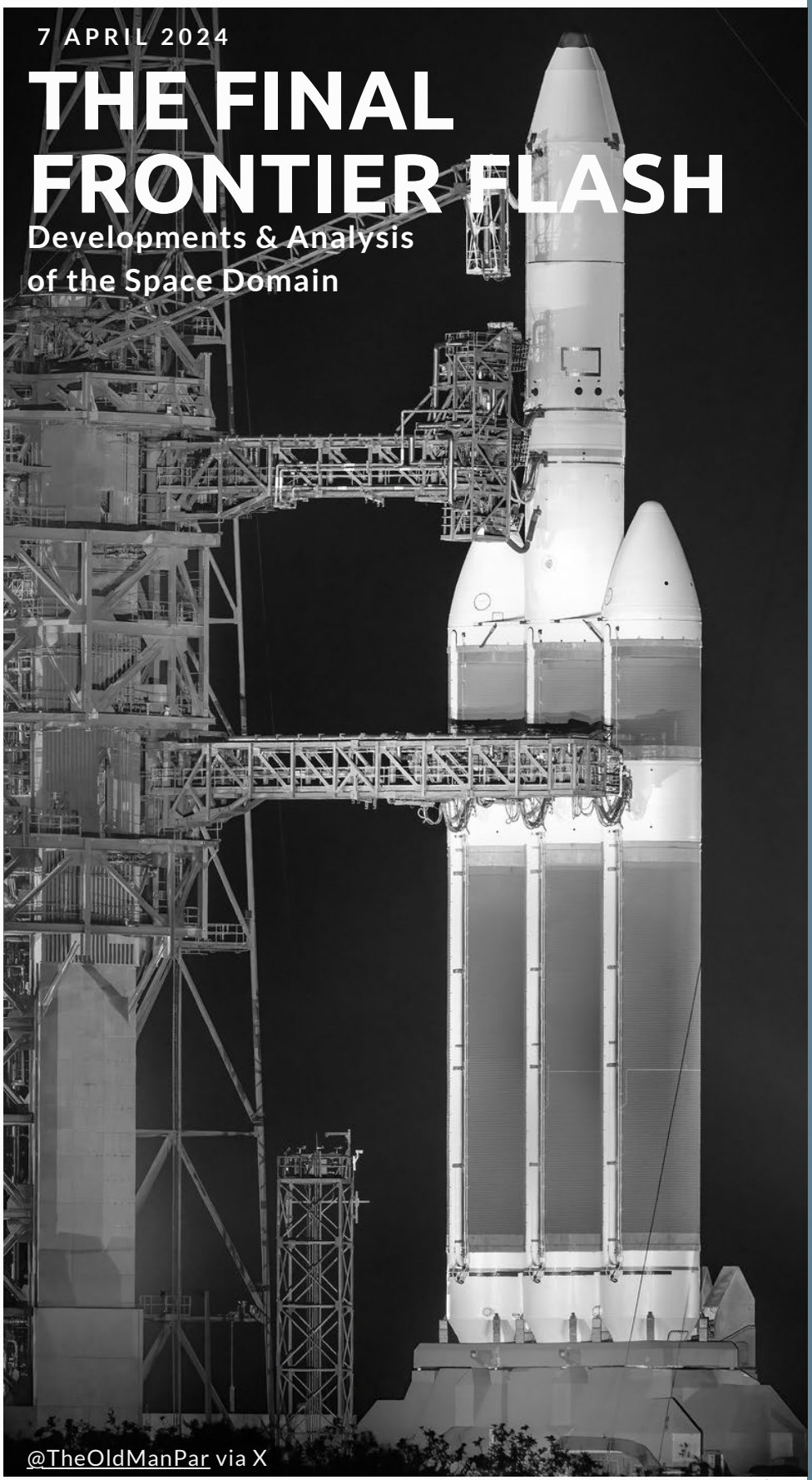
7 APRIL 2024

THE FINAL FRONTIER FLASH

Developments & Analysis of the Space Domain



@TheOldManPar via X

contact@integrityisr.com

Catalog

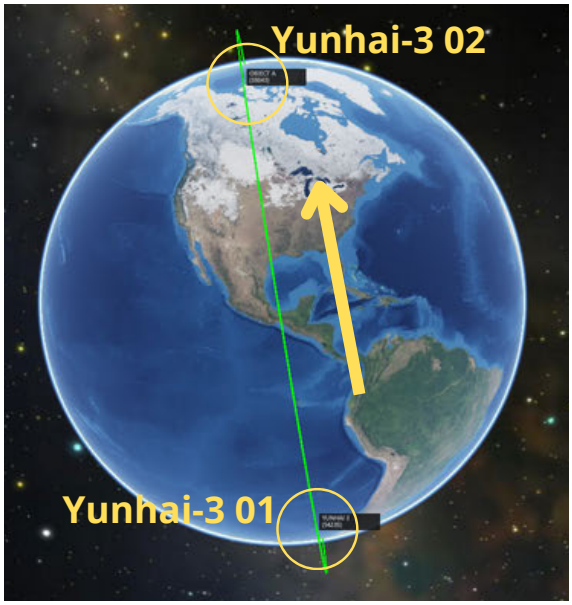
In This Issue

China Launches Yunhai-3 02 Weather Satellite

26 Mar: China launched a Long March-6A from Taiyuan carrying the second Yunhai-3 satellite. The Yunhai-3 02 satellite joins the 6 Yunhai-2 satellites launched on a LM-2D on 21 Mar 2024. Yunhai satellites are used for Environmental Monitoring, and this launch brings the constellation total to 18 satellites. As the name implies, this is the second Yunhai-3 satellite, both are co-planar and in sun-synchronous orbit. Launch Video.

- China used a LM-6 to launch both Yunhai-3 satellites, and both were launched from Taiyuan. Yunhai-3 01 launched on 11 Nov 2022.
- The altitude of both Yunhai-3 satellites are identical as both have a Semi-Major Axis of 848km.
- China has not released any additional information regarding the mission of the Yunhai satellite constellation. A recent *Space Review* article maintained the constellation has a military purpose.
- This is the second Yunhai satellite launch in less than a week. On 21 Mar 2024 China launched a LM-2D from Jiuquan carrying 6 Yunhai-2 satellites into orbit. The launch was similar to the previous Yunhai-2 satellite launch in Dec 2018.
- Very little is known about the two Yunhai-3 satellites.
- There are four Yunhai-1 satellites and they are assessed to complement the information provided by the civil Fengyun meteorological satellites.
- Yunhai 1-01 (2016), 02 (2019) , 03 (2022) and 04 (2023) were all launched from Jiuquan using LM-2Ds.
- Yunhai 1-02 was struck by Russian debris in Mar 2018, likely from the Zenit-2 rocket that launched Russia's Tselina-2 spy satellite in Sep 1996. The collision spawned at least 37 debris objects.
- Yunhai 1-02 apparently survived the violent encounter as amateur radio trackers have continued to detect signals from the satellite, it is unclear if Yunhai 1-02 remains operational.
- There are 12 Yunhai-2 satellites on orbit. Per the *Space Review* article: "The satellites reportedly use Global Navigation Satellite System radio occultation to collect atmospheric data for weather forecasting and for ionosphere, climate, and gravity research."
- In Dec 2018 and Mar 2024 China simultaneously launched 6 Yunhai 2 satellites from Jiuquan using a LM-2D.

LM-6C w/ Yunhai-3 02 (nasaspaceflight.com)

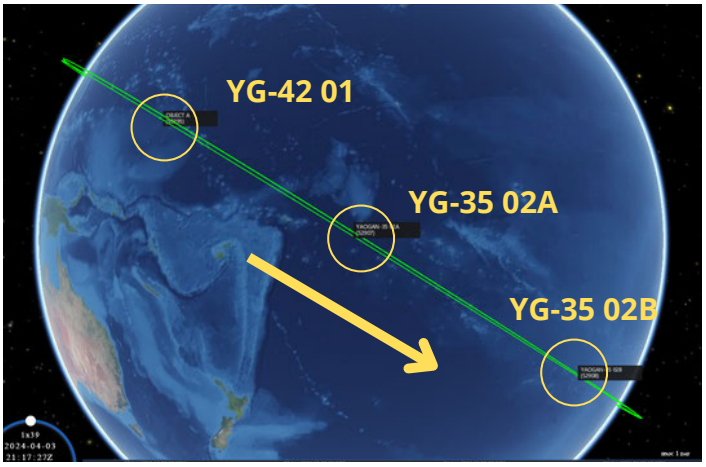


China Launches New Yaogan-42 01 Satellite

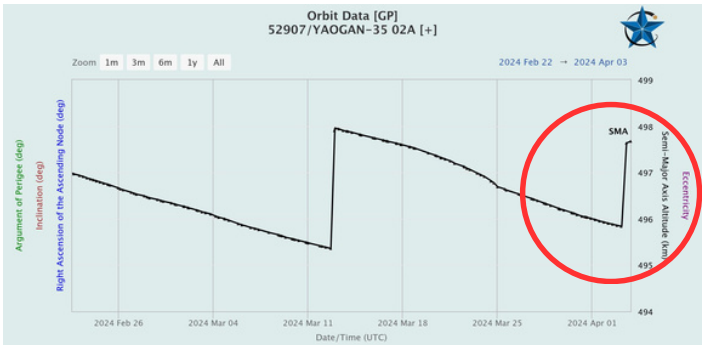
2 Apr 2024: China launched a LM-2D from Xichang carrying the Yaogan-42 01 remote sensing satellite. YG-42 01 appears to be nearly co-planar with Yaogan-35 02A and 02B and is a possible replacement for the Yaogan-35 02C which likely failed back in November 2022. China provided few details of YG-42 01's mission. Launch Video.

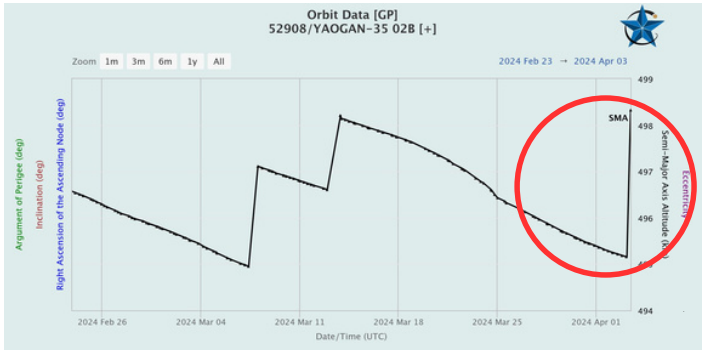
- YG-42 01 is currently in a 504.9 x 494.3km orbit and is inclined 35°. The altitude and inclination match the Yaogan-35/36/39 45 satellite constellation China launched between 2021 and 2023.
- YG-42 01 is nearly co-planar with the YG-35 02A and 02B satellites which China launched on 23 June 2022. The YG-36 02 and YG-39 01 triplets are also in the same orbital plane.
- For the YG-35 02 triplets specifically, YG-35 02B is the "Lead" and YG-35 02A is "Trail1." YG-35 02C was in the "Trail2" position, however it has not maneuvered since November 2022.
- YG-35 02's orbit has gradually deteriorated over the past 16 months and its altitude is now just over 300km. It is likely to re-enter over the South Pacific in the near term.
- On the same day of the YG-42 01 launch, both YG-35 02A and 02B increased their altitudes.
- The coming days/weeks will reveal if YG-42 01 joins the YG-35 02 formation as the "Trail2" satellite replacing the failed YG-35 02C.
- Another of the "Trail2" satellites, YG-36 01B also appears to have failed and has not maneuvered since ~ 22 Jan 2023. Its SMA has decreased over 100km and is now 395.1km and is likely headed for a similar fate as YG-35 02C. If there is a YG-42 02 and it joins the YG-36 01 formation then it is likely the YG-42 satellite is a new "Trail2" variant.
- On 29 Jan 2024, 7 other "Trail2" satellites began decreasing their SMAs. As of 7 April 2024 all of their altitudes have continued to decline. China appears to have done similar maneuvers with some of the Trail2 satellites from Jan-Mar 2023.

Yaogan-42 01 Patch
(@wulei2020 via X)

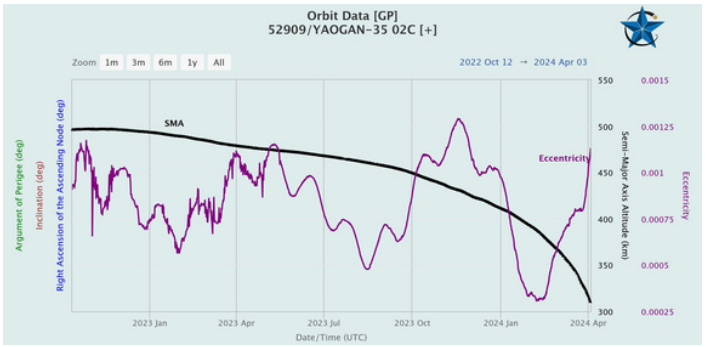


YG-42 01 Possible Replacement for Defunct YG-35 02C
(spaceaware.io)





YG-35 02A and 02B Increased SMA on 3 Apr 2024
(celestrak.org)



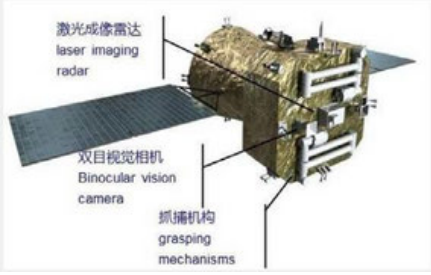
YG-35 02C Has Issues...No Maneuver Since ~ 22 Nov 2022
(celestrak.org)

CASI Article: China Space Logistics Development

18 Mar: China Aerospace Studies Institute (CASI) released an article from researcher Kristin Burke highlighting the People's Liberation Army (PLA)'s interest and investment in developing on-orbit servicing capabilities. The PLA is preparing its satellite operators to perform on-orbit satellite refueling, for peacetime and wartime space logistics. They are also already integrating lessons learned into corresponding military doctrine and training tools. More excerpts below. Full Article.

- The Chinese Communist Party (CCP) has approved new commercial players to enter the field to provide, not only technology, but also frameworks to shape international norms.
- In 2018, a Beijing based Strategic Support Force (SSF) unit under the Space Systems Department (SSD) published a comprehensive article on the PLA's requirements for a simulation tool to train military satellite operators in space-based refueling.
- In 2022 the PLA's National University for Defense Technology (NUDT) recommended adding specific fuel and time requirements for five anticipated mission sets: 1) on-orbit refueling and repair; 2) auxiliary position maintenance; 3) adjusting inclination; 4) deorbiting a defunct satellite; and 5) rescuing a failed satellite.
- The PLA has been developing policy and doctrine for on-orbit logistics.
- The PLA's Academy of Military Sciences (AMS) published the Lectures on the Science of Space Operations in 2013, which described the importance of having a military unit capable of supporting space equipment sustainment with on-orbit logistics. The book specifically mentions refueling and repair.
- The PLA's broader doctrine covering all military operations, not just space operations, mentions in-space servicing. The PLA National Defense University's 2020 Science of Military Strategy stated that "orbital services" are an important development trend, and that the PLA needs to play a role in the international legal debates on debris disposal.
- PLA experts are writing books to deepen operational planning. In 2021, key PLA satellite servicing experts from the SSF SSD, together with the AMS Joint Operations Experimental Center wrote a dedicated textbook on scheduling satellite servicing and related mission planning.
- Since at least 2016, China's civilian Ministry of Science and Technology has included on-orbit servicing in its technology development plans.
- One Chinese province and two Chinese cities have published 14th Five Year Plans (2021-2025) including technology development support for on-orbit servicing.

China's last and most recent versions of its national space plan have included debris mitigation and significantly expanded the section listing on-orbit servicing plans, to include goals for international cooperation and influencing international norms…a Chinese official document in English describing their plans for international cooperation and negotiation on in-space servicing is a strong signal they are interested in discussing their plans



SAST Display at 2018 Zhuhai Air Show featuring its "on-orbit gas station"
https://www.airuniversity.af.edu/CASI/

Russia Launches Resurs-P no.4

31 Mar: Russia launched a Soyuz-2-1b rocket, carrying the Resurs-P no4 satellite from Baikonur Cosmodrome. It is believed the Resurs-P no 4 & 5 have been significantly modified from the previous 3 Resurs-P satellites (the last of which launched in 2016 and failed to deploy one of its solar panels and was intentionally de-orbited in October 2023.) Launch Video.

- Per Russian News Release: The Resurs-P No. 4 spacecraft is designed for highly detailed, wide-area and hyperspectral optical-electronic observation of the Earth's surface.

-Resurs-P no 4 is in a sun-synchronous orbit with a 462km apogee and 290km perigee and 97.2° inclination. As predicted by er Russianspaceweb.com, Resurs-P4 fired its own propulsion system during on 4 Apr to enter a near-circular Sun-synchronous orbit with an altitude of 470km.

-Resurs-P no 4 and <eventually> P no 5 have significant upgrades compared with their three predecessors (Resurs-P 1, 2, 3). The expected maximum resolution is 1.0m.

-The improvements include a second high-resolution camera which will nearly doubles the amount of Earth's surface that the satellite can image.

-Data downlink rates have also been in increased to 600 megabytes/second.

-Finally, Resures-P no4 no longer carries a AIS ship identification system hitchhiker payload.

-All Resurs-P satellites have been launched from Baikonur and used the Soyuz 2-1b launch vehicle.

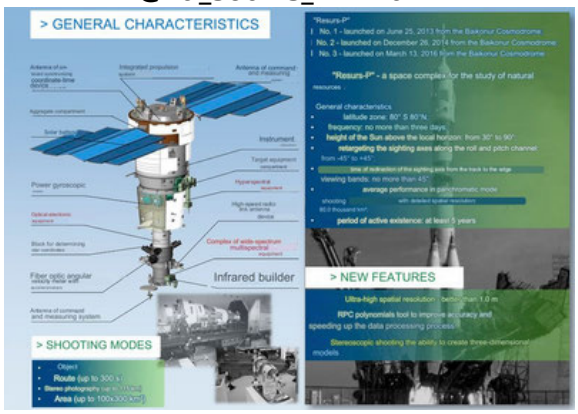
-Western sanctions appear to have significantly delayed Resurs-P no4 (and no5) as #4 was originally scheduled to be launch in 2018 and #5 in 2019, but both were postponed due to the unavailability of certain components.

-Resurs-P no4 is the only operational Resurs-P satellite. Per Russianspaceweb.com "Resurs-P2 failed prematurely in 2017, while Resurs-P3 was seriously crippled by technical problems in the same year. The original Resurs-P1 lasted the longest, before going out of business in the Fall of 2021, thus leaving Roskosmos and its customers without a spacecraft in this class."

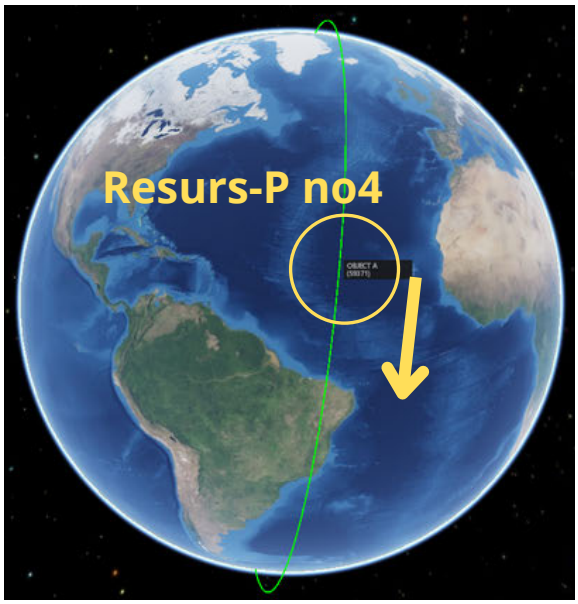
- Russia intentionally de-orbited Resurs-P no3 in October 2023. It had been paired with the experimental Russian satellite, Kosmos-2562 fromOct 2022 - Jul 2023.

-Resurs-P no5 is expected to launch in 2025.

Resurs-P no 4 Preparing For Launch @La_souris_DA via X



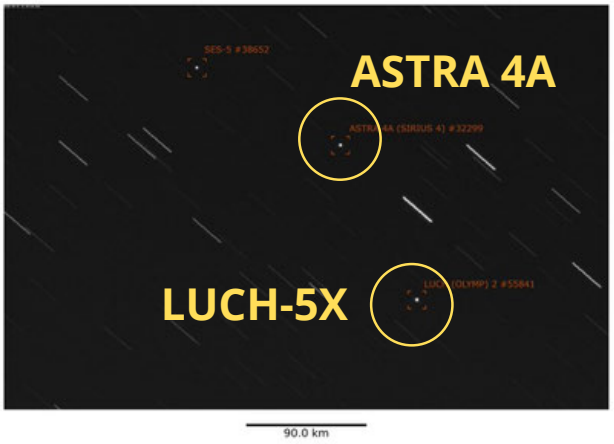
Details of Resurs-P no4 and Previous Resurs-P satellites @SenoreAmore via X



Resurs-P no4 Orbit spaceaware.io

LUCH-5X Relocates Near Jammed Satellite

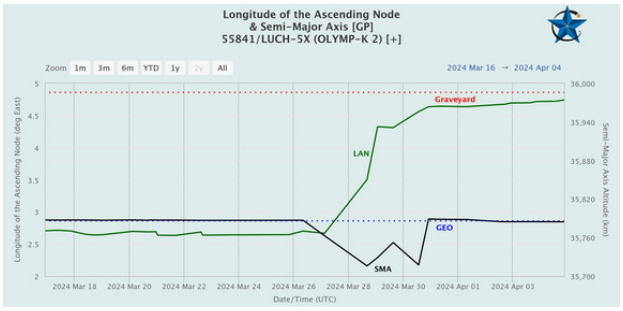
5 Apr 2024: After maintaining its orbit at 2.63°E from 5 Dec 2023 - 26 Mar 2024 (and in vicinity of EUTE KONNECT VHTS), Russia decreased LUCH-5X altitude ~47km on 27 Mar, drifted east for 2-3 days, and rejoined the GEO belt on 30 Mar at 4.7°E. LUCH-5X is now in vicinity of ASTRA 4A which carries broadcast television for Ukraine. ASTRA 4A was jammed by Russian sources (likely from the ground) on 28 March. It appears Russia was able to temporarily disrupt a Ukrainian United News telethon and content from other broadcasters and replace with Russian propaganda content.



LUCH-5X Positioned IVO ASTRA 4A at 4.7°E (@s2a_systems via X)

-Since arriving in GEO in mid-March 2023 LUCH-5X has operated IVO the following satellites:

- 58°E: 6 Apr - 3 May unknown object of interest, the closest object (POCA ~308 km) was COSMOS 1897, a dead Russian COMSAT launched in 1987.
- 9.0°E: 22 May - 25 Sep operating in vicinity of Eutelsat 9B.
- 3.2°E: 5 Oct - 3 Dec in vicinity of Eutelsat 3B. Reported POCA ~16 km.
- 2.6°E: 5 Dec - 26 Mar in vicinity of EUTE KONNECT VHTS
- 4.7°E: 30 Mar - Present Operating in vicinity of ASTRA 4A. POCA ~12.6km.

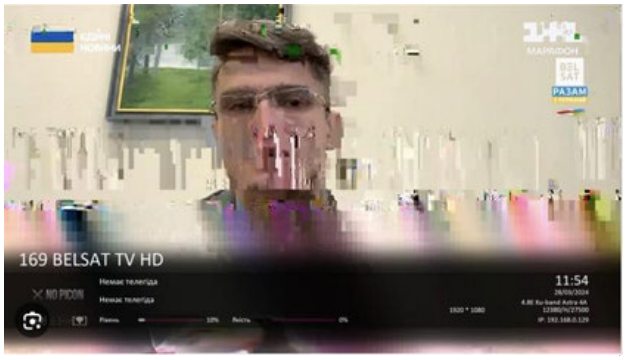


LUCH-5X SMA/Longitude Changes Late-March (celestrak.org)

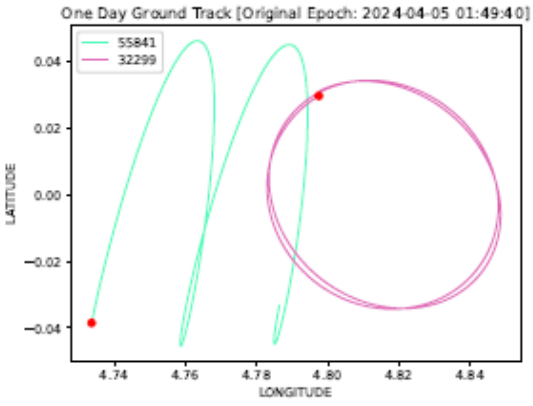
- Additional information from Bart Hendrickx:

"There are at least 3 reasons to believe that Luch-5X is *not* directly involved in the jamming of ASTRA 4A on 28 March:

- Neither Luch-5X nor is predecessor Luch/Olimp have demonstrated jamming capability
- Luch-5X hadn't yet arrived at its new location on 28 March 2024
- The jamming reportedly began in early March and also affected at least one other satellite (Hotbird 13E), which is not being shadowed by any Russian satellites. This strongly indicates the jamming is being done from the ground.
- Still, the fact that Luch-5X is visiting Astra 4A right after the reported jamming can hardly be a coincidence. What the exact connection is remains open to speculation."



Signal Disruption Affecting BELSAT TV (nasaspaceflight.com)



LUCH-5X (Green) Relative Position to ASTRA 4A (Pink)
Point of Closest Approach 12.6km
(5 April 2024 Palski SDA Report)

Christmas in April: SWF Releases 2024 Counterspace Report

2 Apr 2024: Secure World Foundation (SWF) released their annual open source assessment of Global Counterspace Capabilities. In general, an increasing number of countries are looking to use space to enhance their military capabilities and national security which in turn incentivizes more nations to invest in developing counterspace capabilities. While evidence shows "significant research and development of a broad range of destructive and non-destructive counterspace capabilities in multiple countries, only non-destructive capabilities are actively being used against satellites in current military operations." Executive Summary excerpts below.

-Russia:

- There is strong evidence that Russia has embarked on a set of programs since 2010 to regain offensive counterspace capabilities.
- Russia has been testing technologies for RPO in both LEO and GEO that could lead to or support a co-orbital ASAT capability, and some of those efforts have links to a Cold War-era LEO co-orbital ASAT program.
- In November 2021…Russia successfully demonstrated a DA-ASAT capability against a LEO satellite. It is unclear whether this system, the Nudol, will become operational soon.
- New evidence suggests Russia may be developing high-powered space-based EW platforms to augment its existing ground-based platforms.
- Russia is pursuing lofty goals of incorporating EW capabilities throughout its military to both protect its own space-enabled capabilities & degrade or deny those adversary capabilities.

-China

- China has conducted multiple tests of technologies for close approach and rendezvous in both low-earth orbit (LEO) and geostationary earth orbit (GEO) that could lead to a co-orbital ASAT capability.
- China has at least one, and possibly as many as three, programs underway to develop DA-ASAT capabilities
- Chinese DA-ASAT capability against LEO targets is likely mature and may be operationally fielded on mobile launchers.
- DA-ASAT capability against deep space targets (medium Earth orbit, or MEO, and GEO) is likely still in the experimental or development phase.
- China designated space as a military domain, & military writings state that the goal of space warfare and operations is to achieve space superiority using offensive/defensive means
- China's considerable investment in developing and testing counterspace capabilities suggest they see space as a domain for future conflict

	US	RUSSIA	CHINA	INDIA	AUS.	FRANCE	IRAN	ISRAEL	JAPAN	N. KOREA	S. KOREA	UK
LEO Direct Ascent	▢	▢	▲	▢	●	●	●	●	●	●	●	●
MEO/GEO Direct Ascent	▢	▢	▢	●	●	●	●	●	●	●	●	●
LEO Co-Orbital	▢	▲	▢	●	●	●	●	●	●	●	●	●
MEO/GEO Co-Orbital	▢	▢	▢	●	●	●	●	●	●	●	●	●
Directed Energy	▢	▢	▢	●	●	▢	●	●	●	●	●	●
Electronic Warfare	▲	▲	▲	▢	▢	▢	▢	▲	▢	▢	●	●
Space Situational Awareness	▲	▲	▲	▢	▢	▢	▢	▢	▢	▢	▢	▢

LEGEND: NONE ● SOME ▢ SIGNIFICANT ▲ UNCERTAIN ? NO DATA –

Secure World Foundation Assessment of Counterspace Capabilities by Nation
(2024 SWF Global Counterspace Capabilities Open Source Assessment)

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SP310 - Adversary Space Capabilities II

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SP103 - Math for Space
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SP202 - Advanced OrbitalMechanics
SP203 - Joint Planning Process
SP204 - Space Surveillance Network/Object Surveillance & ID
SP301 - Electromagnetic Warfare
SP302 - Cyberspace
SP303 - Anti-Satellite Weapons

Space Specializations - Coming This Fall!
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SP410 - Rendezvous and Proximity Operations
SP420 - Space Domain Awareness
SP430 - Space Control
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SP480 - Intelligence Support to Space

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AW100 - Foundations of Analytic Writing
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CT600 - Critical Thinking for Learning Professionals
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DA100 - Foundations of Data Analytics
DA200 - The Art & Science of Data Analytics

Cyber
CYBER900 - Cyber Security Strategy
ENG200 - English for Cyber

Faculty Development
FD600 - Facilitation for Learning Professionals
CT600 - Critical Thinking for Learning Professionals

ISR - Analysis
PED100 - Intelligence Planning Cycle
EM110 - Electromagnetic Spectrum Fundamentals
IADS100 - IADS Foundations
IADS200 - Rethinking IADS
IADS310 - Advanced IADS Analysis

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TGT211 - Target Development II
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TGT213 - Target Force Assignments
TGT214 - Mission Planning & Force Execution
TGT215 - Combat Assessment
TGT310 - Weaponeering and Collateral Damage Assessment
TGT311 - HVI Target Development
TGT312 - Precision Point Mensuration
TGT315 - Targeting Professional

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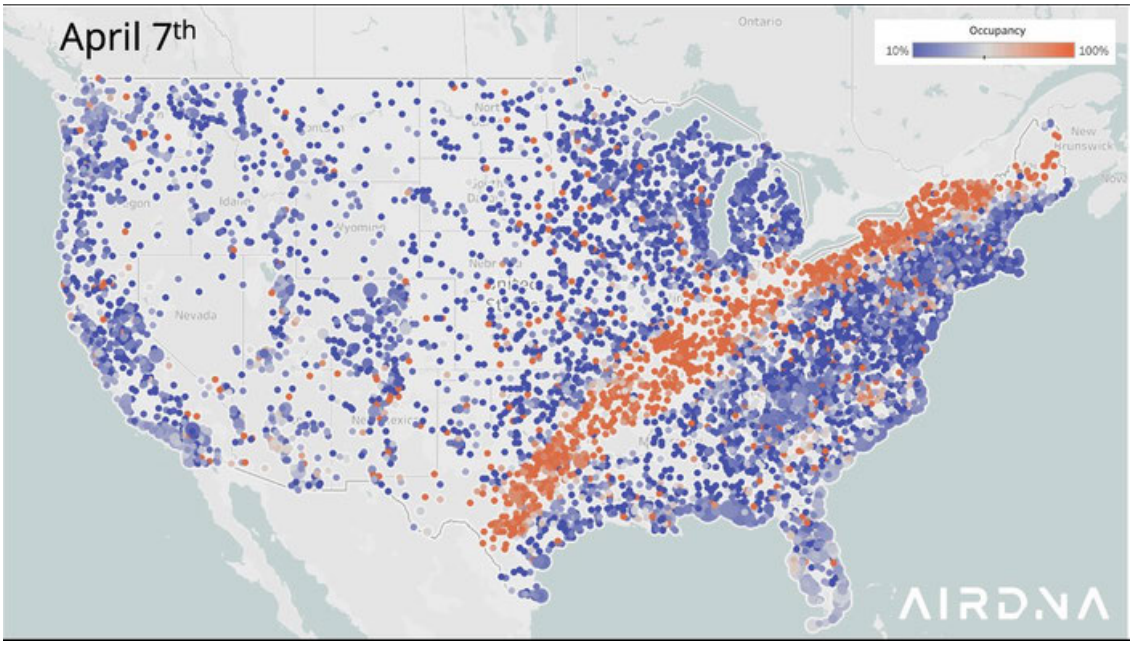
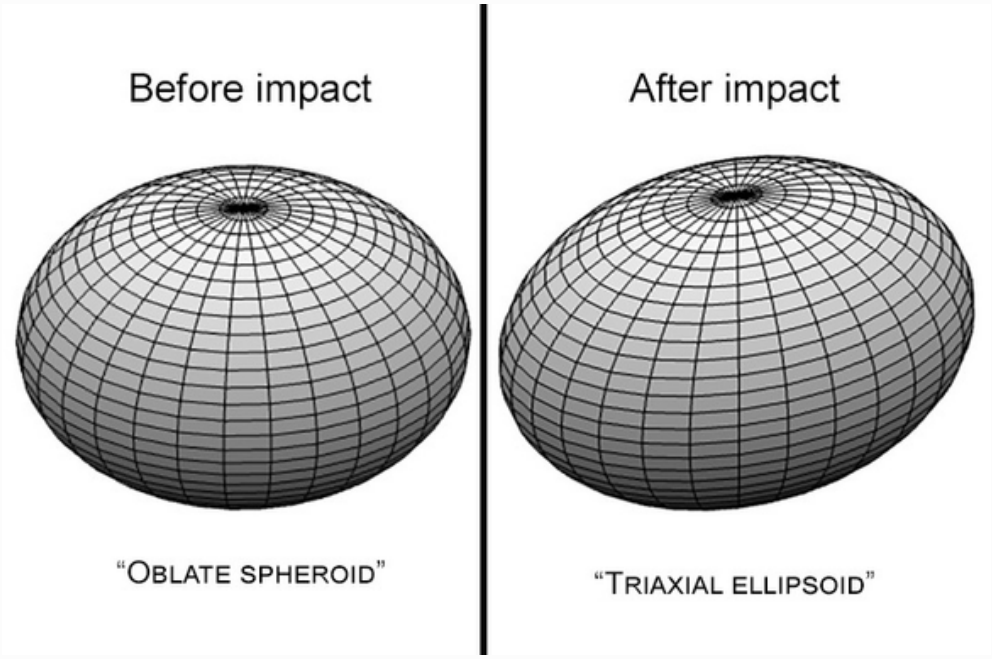
Pics o' the week!

Parenting like a Boss. Tip of the Cap to this Dad (and Mom...who probably planned the trip, remembered to bring the camera & insisted on taking the photo!) (@ZachsORoutdoors via X)



Happy Eclipse Viewing for all those who Observe. Map of fully booked AirBnBs next week. (@mikesimonsen via X)

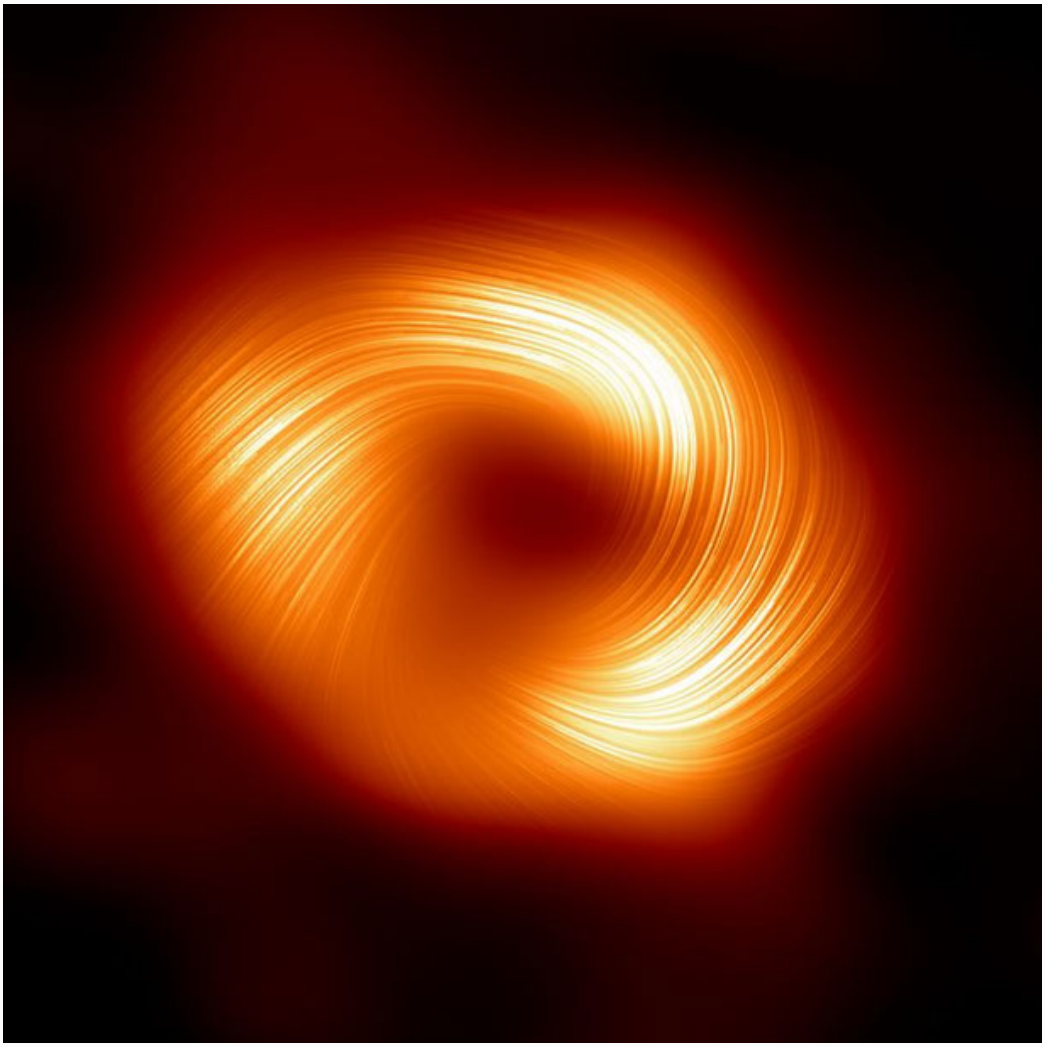
Kind of Close to Home: fireball over California caused by the reentry of China's Shenzhou 15 orbital module (space.com)



Follow Up Graphic from 24 March FFF: When the DART mission crashed into this asteroid, we discovered:
- it was more rubble than solid
- we changed its orbit
- we changed its shape
(@Cmdr_Hadfield via X)

Space Pioneer Reveals 9 Engine Configuration of Tianlong-3 first stage. First stage hot fire test is planned for Apr 2024 (@raz_liu via X)

Northern lights from the A350 flight deck (@webflite via X)



Event Horizon Telescope team unveils strong magnetic fields spiraling at the edge of Milky Way's central black hole, Sagittarius A*. This new image suggests that strong magnetic fields may be common to all black holes. (@ehtelescope via X)

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.

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