

Modern Technologies and Conflicts

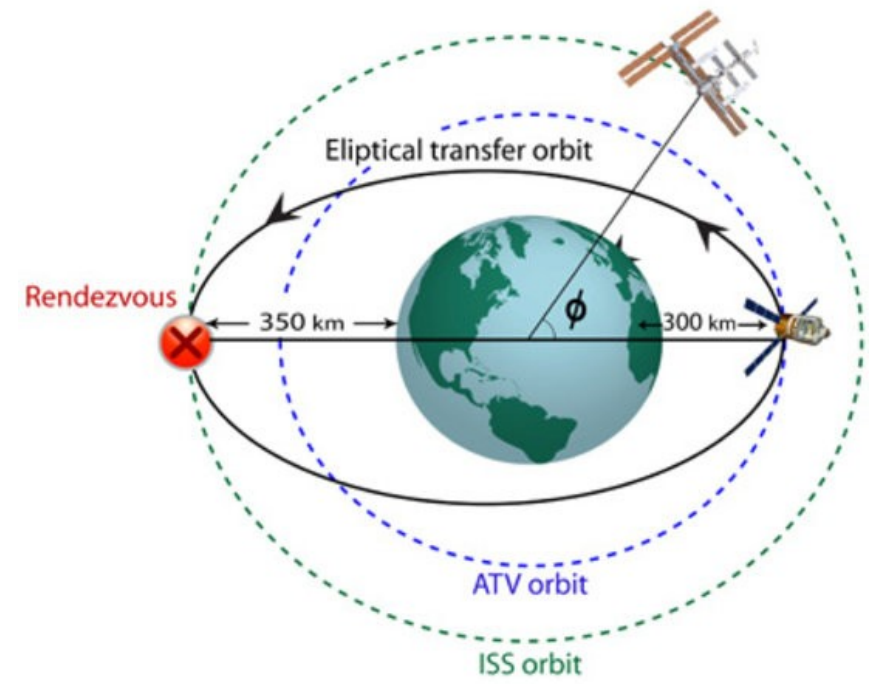
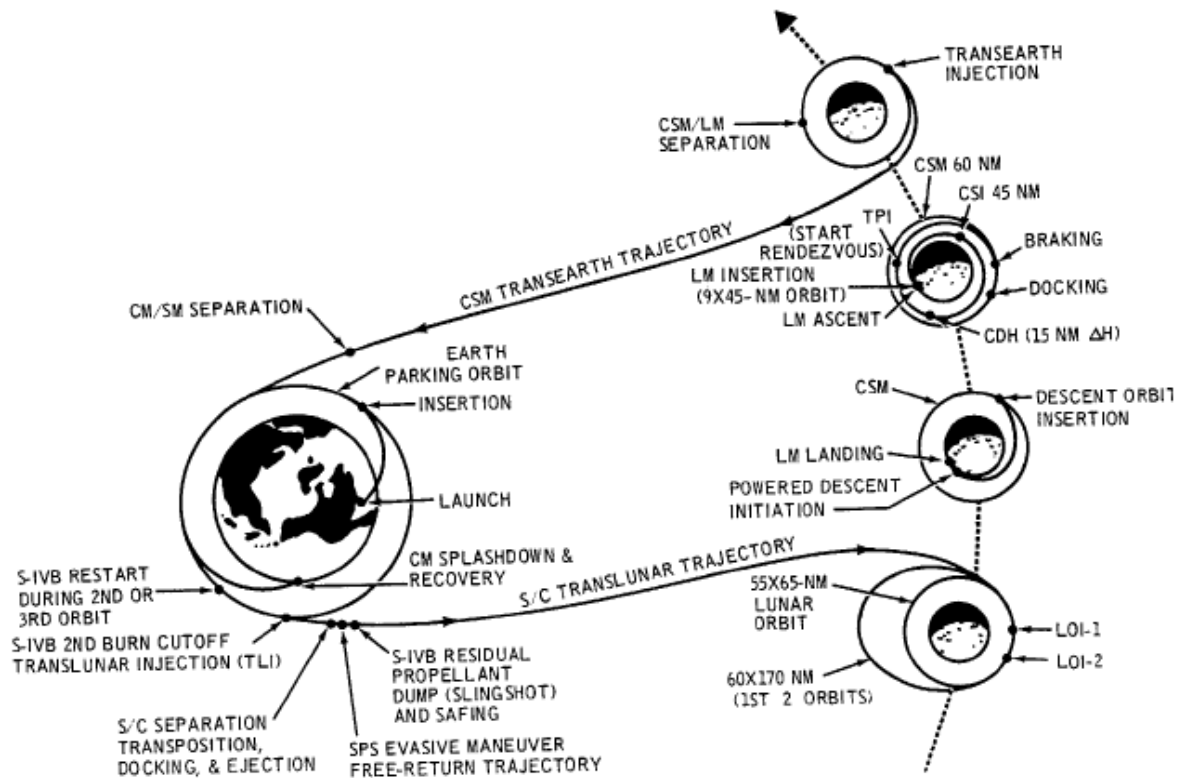


Space Security

19.10.2022

Marek Dvořáček





- Neil Armstrong and Buzz Aldrin
- Pete Conrad, Alan Bean,
- Alan Shepard, Edgar Mitchell,
- David Scott, James Irwin,
- John Young, Charles Duke,
- Eugene Cernan, Harrison Schmitt





Expedition 68 mission patch

<https://www.nasa.gov/sites/default/files/atoms/files/exp-68-summary.pdf>



Mission	Launch date (NET)	Spacecraft	Type	Launch vehicle	Launch site	Launch provider	Docking/berthing port
Progress MS-21	26 October 2022 ^[277] ^[278]	Progress MS No. 451	Uncrewed	Soyuz-2.1a	🇷🇺 Baikonur Site 31/6	🇷🇺 Roscosmos	<i>Poisk</i> zenith
			Module				
NG-18	6 November 2022 ^[277] ^[279]	S.S Sally Ride	Uncrewed	Antares 230+	🇺🇸 Wallops Pad OA	🇺🇸 Northrop Grumman	<i>Unity</i> nadir
SpX-26	18 November 2022 ^[277] ^[279]	Cargo Dragon C211	Uncrewed	Falcon 9 Block 5	🇺🇸 Kennedy LC-39A	🇺🇸 SpaceX	<i>Harmony</i> zenith
			Module				
SpX-27	10 January 2023 ^[277] ^[279]	Cargo Dragon	Uncrewed	Falcon 9 Block 5	🇺🇸 Kennedy LC-39A	🇺🇸 SpaceX	<i>Harmony</i> zenith
			Module				
Boe-CFT	February 2023 ^[280] ^[277] ^[279] ^[281]	Boeing Starliner <i>Calypso</i>	Crewed	Atlas V N22	🇺🇸 Cape Canaveral SLC-41	🇺🇸 United Launch Alliance	<i>Harmony</i> forward
AX-2	Q1 2023	Crew Dragon	Crewed	Falcon 9 Block 5	🇺🇸 Kennedy LC-39A	🇺🇸 SpaceX	<i>Harmony</i> forward or zenith
HTV-X1	Q2 2023 ^[277]	HTV-X	Uncrewed	H3-24L	🇯🇵 Tanegashima LA-Y2	🇯🇵 JAXA	<i>Harmony</i> nadir
Progress MS-22	20 February 2023 ^[277] ^[278]	Progress MS No. 452	Uncrewed	Soyuz-2.1a	🇷🇺 Baikonur Site 31/6	🇷🇺 Roscosmos	<i>Zvezda</i> aft
NG-19	February 2023 ^[277] ^[279]	Cygnus	Uncrewed	Antares 230+	🇺🇸 Wallops Pad OA	🇺🇸 Northrop Grumman	<i>Unity</i> nadir
SNC-1	February 2023 ^[277] ^[279] ^[282]	Dream Chaser <i>Tenacity</i>	Uncrewed	Vulcan Centaur VC4L	🇺🇸 Cape Canaveral SLC-41	🇺🇸 United Launch Alliance	<i>Harmony</i> nadir
Soyuz MS-23	20 March 2023	Soyuz MS	Crewed	Soyuz-2.1a	🇷🇺 Baikonur Site 31/6	🇷🇺 Roscosmos	<i>Prichal</i> nadir
SpaceX Crew-6	March 2023	Dragon 2 Endeavour}}	Crewed	Falcon 9 Block 5	🇺🇸 Kennedy LC-39A	🇺🇸 SpaceX	<i>Harmony</i> forward or zenith
AX-3	H1 2023	Crew Dragon	Crewed	Falcon 9 Block 5	🇺🇸 Kennedy LC-39A	🇺🇸 SpaceX	<i>Harmony</i> forward or zenith
HTV-X2	April 2023 ^[277]	HTV-X	Uncrewed	H3-24L	🇯🇵 Tanegashima LA-Y2	🇯🇵 JAXA	<i>Harmony</i> nadir
SpX-28	5 June 2023 ^[277] ^[279]	Cargo Dragon	Uncrewed	Falcon 9 Block 5	🇺🇸 Kennedy LC-39A	🇺🇸 SpaceX	<i>Harmony</i> zenith
Progress MS-23	20 February 2022 ^[277] ^[278]	Progress MS No. 453	Uncrewed	Soyuz-2.1a	🇷🇺 Baikonur Site 31/6	🇷🇺 Roscosmos	<i>Poisk</i> zenith
Soyuz MS-24	21 September 2023	Soyuz MS	Crewed	Soyuz-2.1a	🇷🇺 Baikonur Site 31/6	🇷🇺 Roscosmos	<i>Rassvet</i> nadir
Starliner-1	September 2023 ^[277] ^[279]	Boeing Starliner SC-2	Crewed	Atlas V N22	🇺🇸 Cape Canaveral SLC-41	🇺🇸 United Launch Alliance	<i>Harmony</i> forward





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Soyu



Home > Astronomy & Space > Space Exploration > May 31, 2017

Space junk could

May 31, 2017



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VOJENSKÉ ZPRAVODAJSTVÍ

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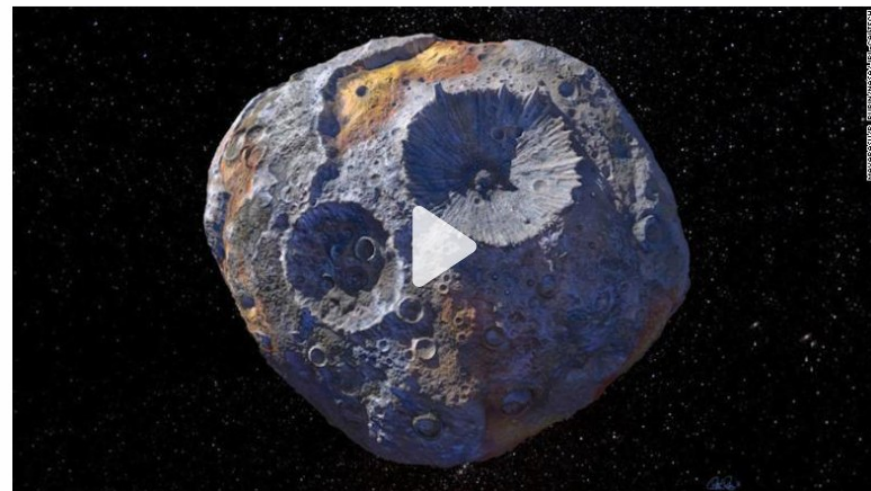
AKTUALIZOVÁNO

Slovenská policie vraždy novináře J čtvrtek ráno o tom informoval slovenský Den

How the Kessler Syndrome can end

Psyche, an asteroid believed to be worth \$10,000 quadrillion, is observed through Hubble Telescope in new study

By Francesca Giuliani-Hoffman, CNN Updated 0354 GMT (1154 HKT) November 2, 2020



An asteroid in space possibly worth more than the entire economy of our planet 01:23

(CNN) — A rare metallic asteroid about three times farther away from the sun than our planet could yield secrets about Earth's molten core, and scientists want to learn all about it.

A new study published Monday in The Planetary Science Journal takes a closer look at this mysterious asteroid, using data from the Hubble Telescope.

Located between Mars and Jupiter, Asteroid 16 Psyche is one of the most massive objects in the

27. s

Exploring space is one of humanity's most hopeful activities. By going out into the great unknown of the Universe, we hope to extend our reach, find new resources and life forms, while solving many of our earthly problems.

News & buzz



Officials say defense secretary is prepared for possibility...

Armed men arrested in Philadelphia may have believed fake...

the US with a space attack,

The Guardian International edition

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Live Lewis Hamilton wins the Russian Grand Prix - as it happened

Live Ryder Cup 2018: Europe 10.5-8.5 USA - Sunday singles live!

Indonesia tsunami: death toll could reach thousands, officials say

Live Tsunami in Indonesia: death toll at 832 and expected to rise sharply - live updates

porujeme



Analyses Sections Forums

Omar Lamrani Senior Military Analyst, Stratfor

Omar Lamrani focuses on air

SPACE

Satellite operator Viasat climbs 27% after selling military communications unit to L3Harris for \$2 billion

PUBLISHED MON, OCT 3 2022-11:20 AM EDT | UPDATED MON, OCT 3 2022-4:07 PM EDT

Michael Sheetz @THESHEETZTWEETZ

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- KEY POINTS**
- California-based satellite operator business to defense contractor L3Harris
 - Viasat is selling its "Link 16 Tactical Communications System" that connects military assets through a secured voice and data link

GAO: Defense, intelligence agencies need a better plan to buy commercial satellite imagery

by Sandra Erwin — September 7, 2022



Satellite image collected by BlackSky over Vasylykiv Air Base, Ukraine, Feb. 28. Credit: BlackSky

GAO director Brian Mazanec: 'Commercial satellite capabilities are increasingly going to be indispensable to the national security enterprise'

SPACE NEWS

As DoD grows more reliant on the relationship

by Sandra Erwin — September 22, 2022

DoD and the intelligence community would use commercial space



ORGANIZATION | TOPICS |

e-Library > Official texts (Ch...

NATO's over...

17 Jan. 2022 - | Last updated: 1

English | French

Exclusive: Musk's SpaceX says it can no longer pay for critical satellite services in Ukraine, asks the tab

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as Iran of jamming its

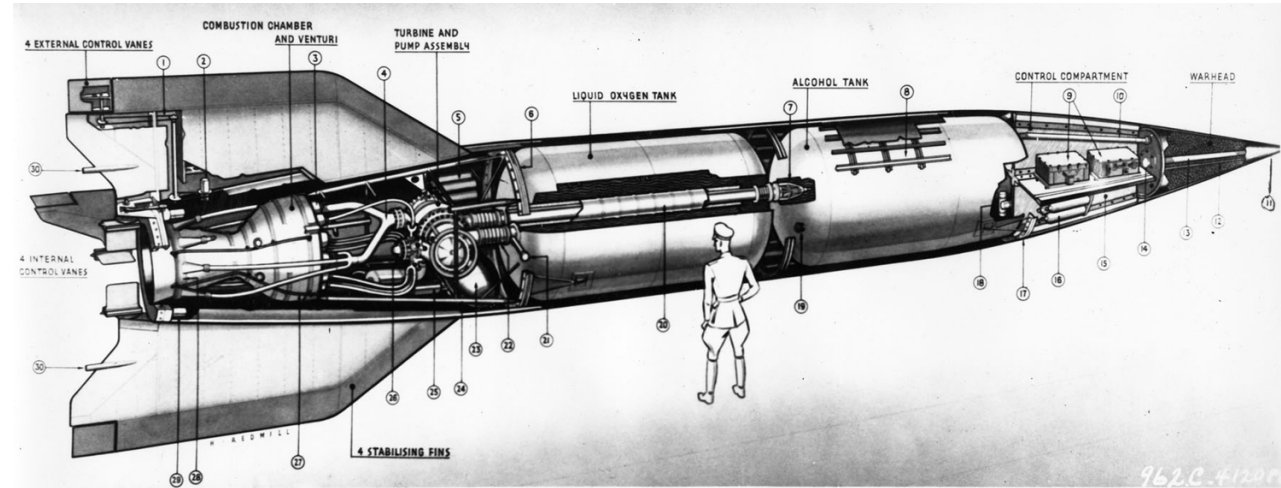


1) Outer space and Kármán line

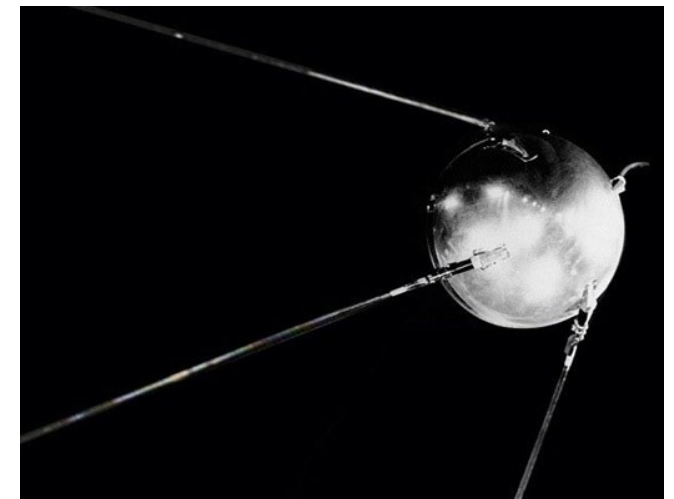
- the atmospheric boundary at the altitude of 100 km (62 miles) the highest achievable point for ordinary aviation: Aeronautics
- the highest achievable point for ordinary aviation: Aeronautics
- the lowest point under which the atmosphere is too dense for a spacecraft to remain on a stable orbit without a continuous pull of its drive: Astronautics
- *(altitude where the speed necessary to aerodynamically support the airplane's full weight equals orbital velocity (assuming wing loading of a typical airplane). In practice, supporting full weight wouldn't be necessary to maintain altitude because the curvature of the Earth adds centrifugal lift as the airplane reaches orbital speed)*

2) history – 1942

- Vergeltungswaffe 2



- 1957
Sputnik-1



Satellites

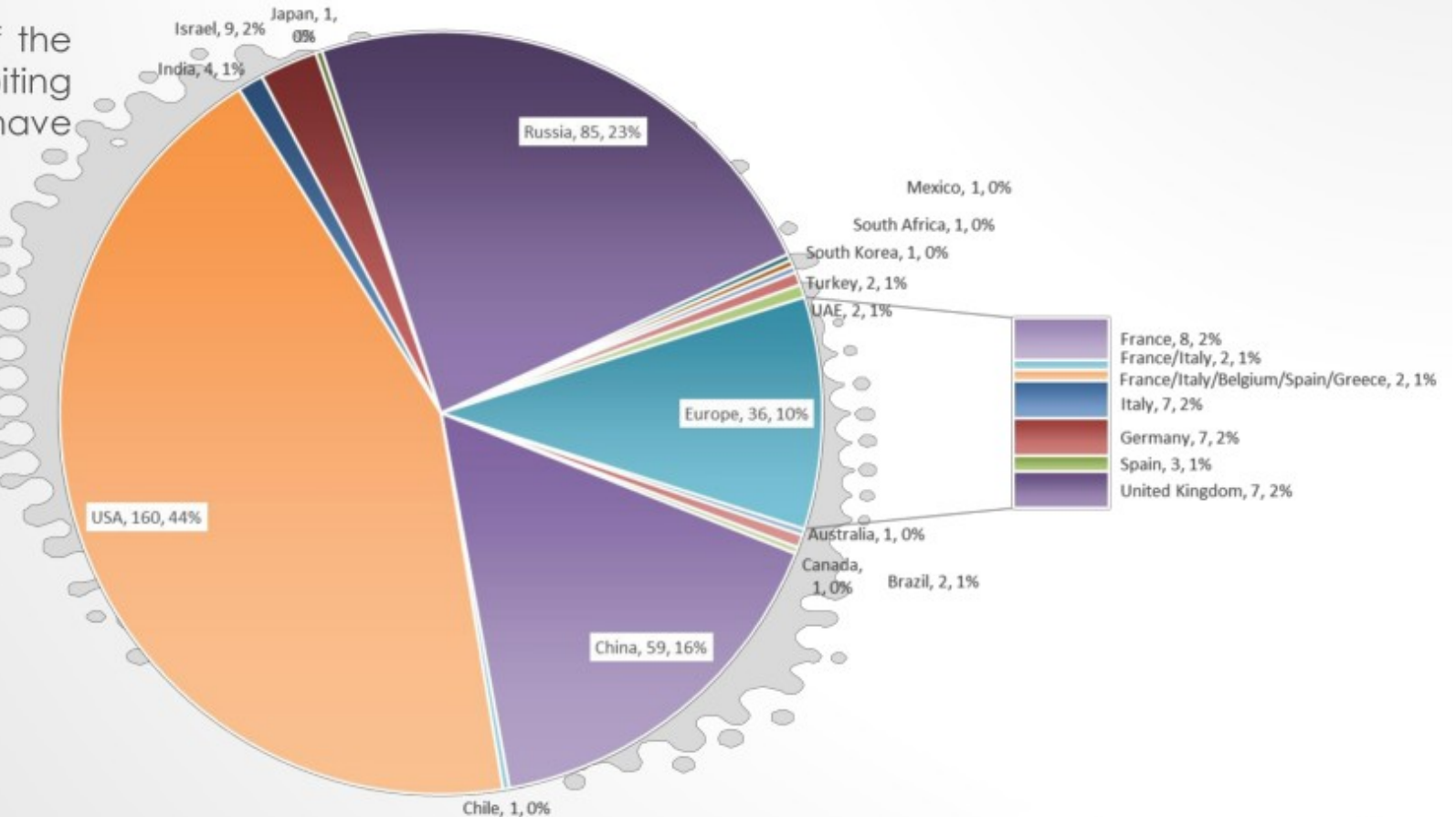
NATIONAL DEFENCE SATELLITES

Approximately 366 satellites of the 1,738 satellites currently orbiting Earth (as at 31 August 2017) have some form of military user.

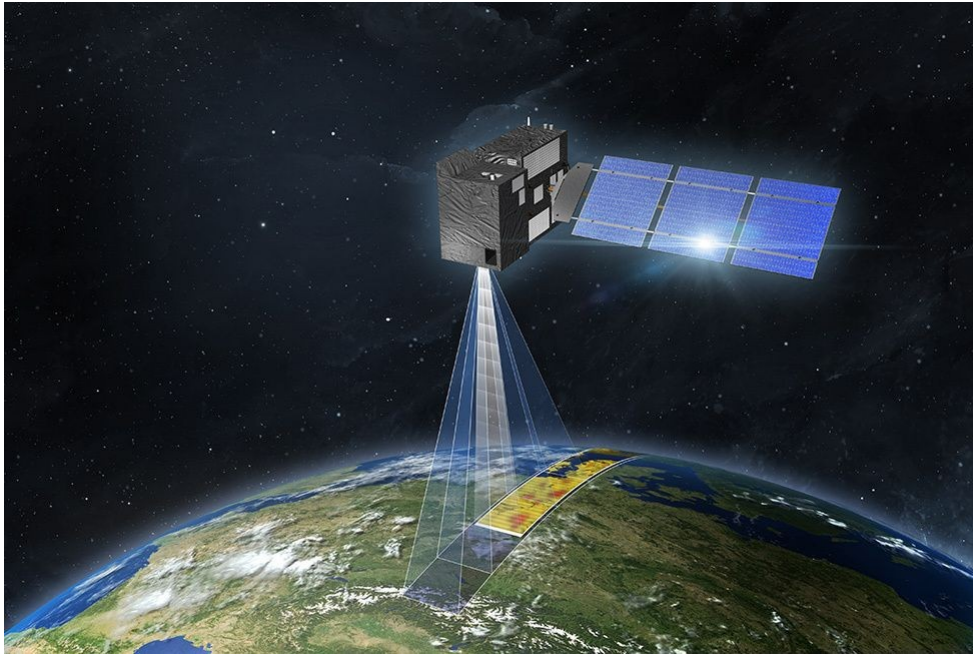
US: 30.6% Remote Sensing (49)
 27.5% Communications (44)
 19.4% Navigation (31)
 17.5% Technology (28)
 3.1% Space Observation (5)
 1.9% Space Science (3)

Russia: 50.6% Communications (43)
 31.8% Navigation (27)
 11.8% Remote Sensing (10)
 2.4% Space Observation (2)
 2.4% Technology (2)
 1.2% Earth Science (1)

China: 50.8% Remote Sensing (30)
 37.3% Navigation (22)
 6.8% Communication (4)
 3.4% Technology (2)
 1.7% Earth Science (1)



Satellites



REPORTS & MULTIMEDIA / FEATURE

UCS Satellite Database

In-depth details on the 5,465 satellites currently orbiting Earth, including their country of origin, purpose, and other operational details.

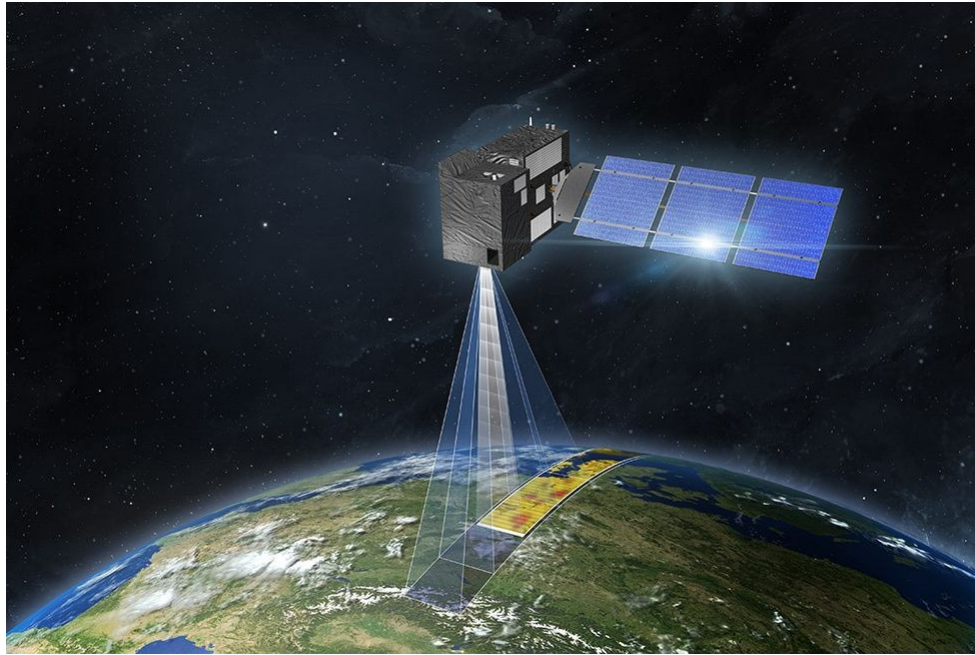
Published Dec 8, 2005 | Updated May 1, 2022

Satellite quick facts

Includes launches through 4/30/2022

- **Total number of operating satellites: 5,465**
 - United States: 3,433
 - Russia: 172
 - China: 541
 - Other: 1,319
- LEO: 4,700
- MEO: 140
- Elliptical: 60
- GEO: 565
- **Total number of US satellites: 3,434**
 - Civil: 31
 - Commercial: 2,992
 - Government: 172
 - Military: 237

Satellites



REPORTS & MULTIMEDIA / FEATURE

UCS Satellite Database

In-depth details on the 4,084 satellites currently orbiting Earth, including their country of origin, purpose, and other operational details.

Published Dec 8, 2005 | Updated May 1, 2021

Satellite quick facts

Includes launches through 4/30/2021

- **Total number of operating satellites: 4,084**
 - United States: 2,505
 - Russia: 168
 - China: 431
 - Other: 980
- LEO: 3,328
- MEO: 139
- Elliptical: 57
- GEO: 560
- **Total number of US satellites: 2,505**
 - Civil: 32
 - Commercial: 2,091
 - Government: 166
 - Military: 216

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GeoInt

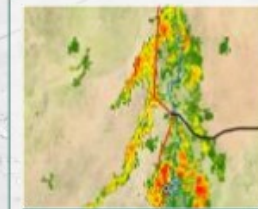
Table 1: Space effects and possible sources (not an all-inclusive list)

Space Services	NATO Uses and Effects	National and Commercial Systems
Position, Navigation, Timing (PNT)	<ul style="list-style-type: none"> • Precision strike • Force navigation • Support to PR/CSAR • Network timing 	<ul style="list-style-type: none"> • Global Positioning System (US) • Galileo (EU)
Integrated Tactical Warning and Threat Assessment	<ul style="list-style-type: none"> • Force protection • Attribution • Missile defence 	<ul style="list-style-type: none"> • Space Based Infrared System (US)
Environmental Monitoring	<ul style="list-style-type: none"> • Mission planning • Munitions selection • Weather forecasting 	<ul style="list-style-type: none"> • Defence Meteorological Satellite Program (US) • EUMETSAT (EU)
Communications	<ul style="list-style-type: none"> • Command and Control • Unmanned Aerial Vehicle ops • Deployed communications 	<ul style="list-style-type: none"> • GBS (US) • Syracuse (FRA) • EUTELSAT (FRA) • SICRAL (ITA) • SKYNET (UK) • INTELSAT (US)
Intelligence, Surveillance and Reconnaissance	<ul style="list-style-type: none"> • Coverage of operation execution (in the operations centre) • Battle Damage Assessment (BDA) • Intelligence • Targeting 	<ul style="list-style-type: none"> • SAR Lupe (DEU) • COSMO SKYMED (ITA) • HELIOS (FRA) • IKONOS (?) (US)
Identification	<ul style="list-style-type: none"> • Automated Identification 	<ul style="list-style-type: none"> • AIS

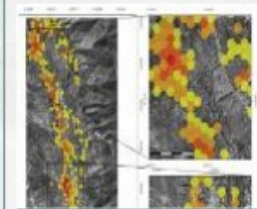
Copernicus Service in Support to EU External Action



Reference Map



Road Network Status Assessment



Conflict Damage Assessment



Critical Infrastructure Analysis



Support to Evacuation Plan



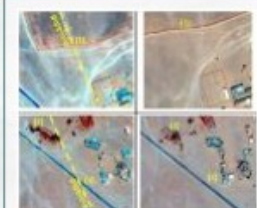
Non-EU Border Map



Camp Analysis



Crisis Situation Picture

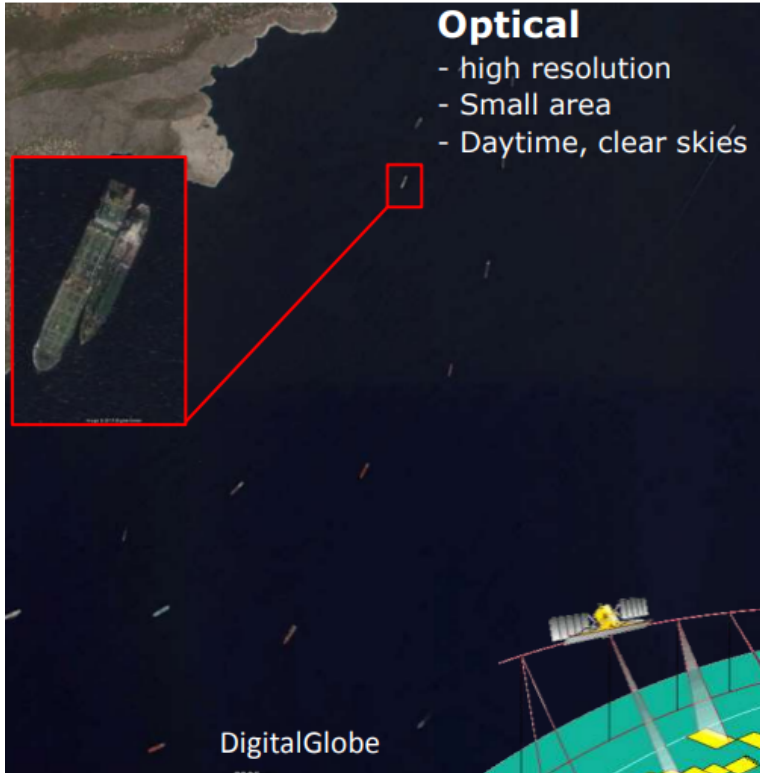


Activity Report

Earth observation satellites



→ Used for **recognition**



Optical

- high resolution
- Small area
- Daytime, clear skies

DigitalGlobe

→ Used for **detection**



Radar

- low resolution
- Wide area
- Through clouds and night

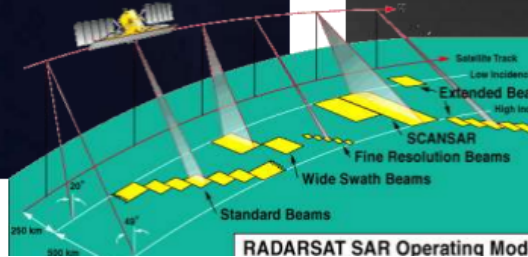
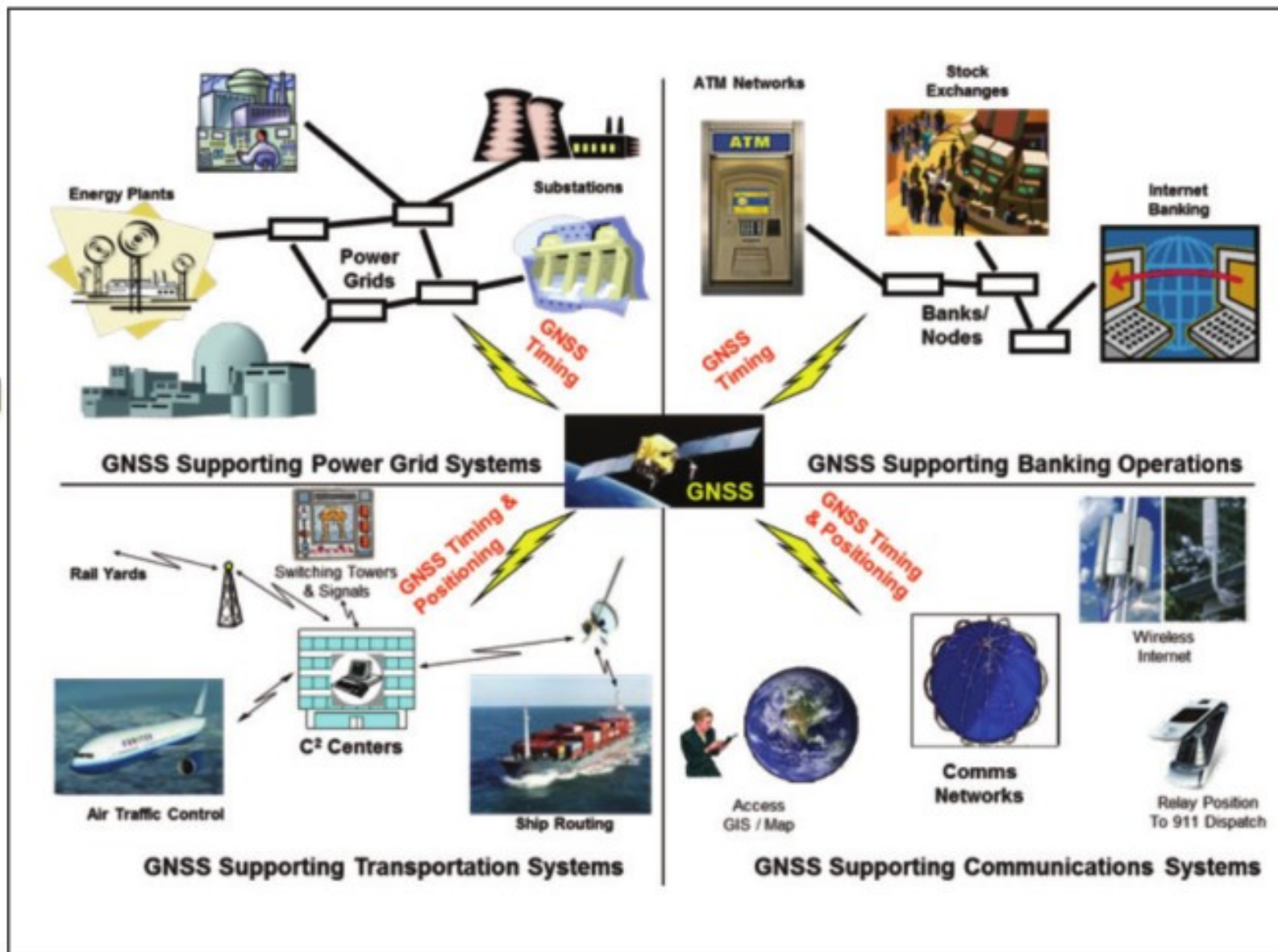
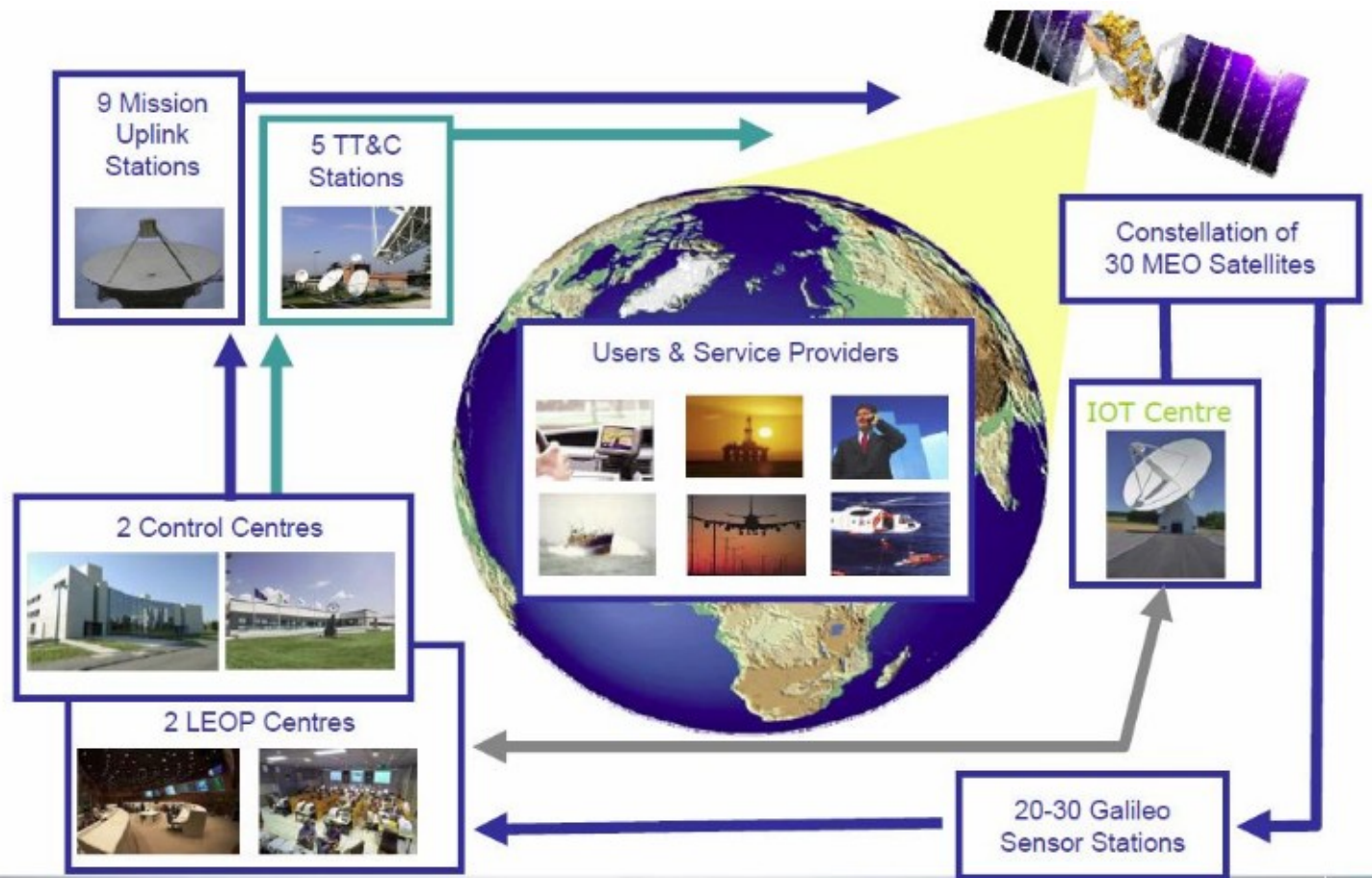


Figure 5: Today's reliance on GNSS positioning and timing signals





Copernicus



<https://www.youtube.com/watch?v=MGJss4IDaBo>



- Support to EU External Actions (implemented in partnership with the European Union Satellite Centre and the Emergency Management Service);
- Maritime surveillance (implemented in partnership with the European Maritime Safety Agency, EMSA);
- Border surveillance (implemented in partnership with FRONTEX).

Space Security Definition:

„Secure and sustainable access to space and its use, as well as freedom from threats emanating from space.“

- Definition based upon Outer Space Treaty principles (of 1967)
- Outer space should remain freely sustainable for all to peaceful use now and in the future

Clay Moltz:

the ability to place and operate assets outside the Earth's atmosphere without external interference, damage, or destruction

The three dimensions of space Security by Jean-François Mayence:

Three dimensions - interrelated areas

I) Outer space for security:

Satellite systems contributing to security and defence initiatives

II) Security in outer space:

Keeping space assets and infrastructure intact against natural and human risks. Maintaining sustainable development

III) Security from outer space:

Protecting humanity and the environment from natural threats and risks originating in outer space

Risks and threats

1) Space debris

- Kessler syndrome

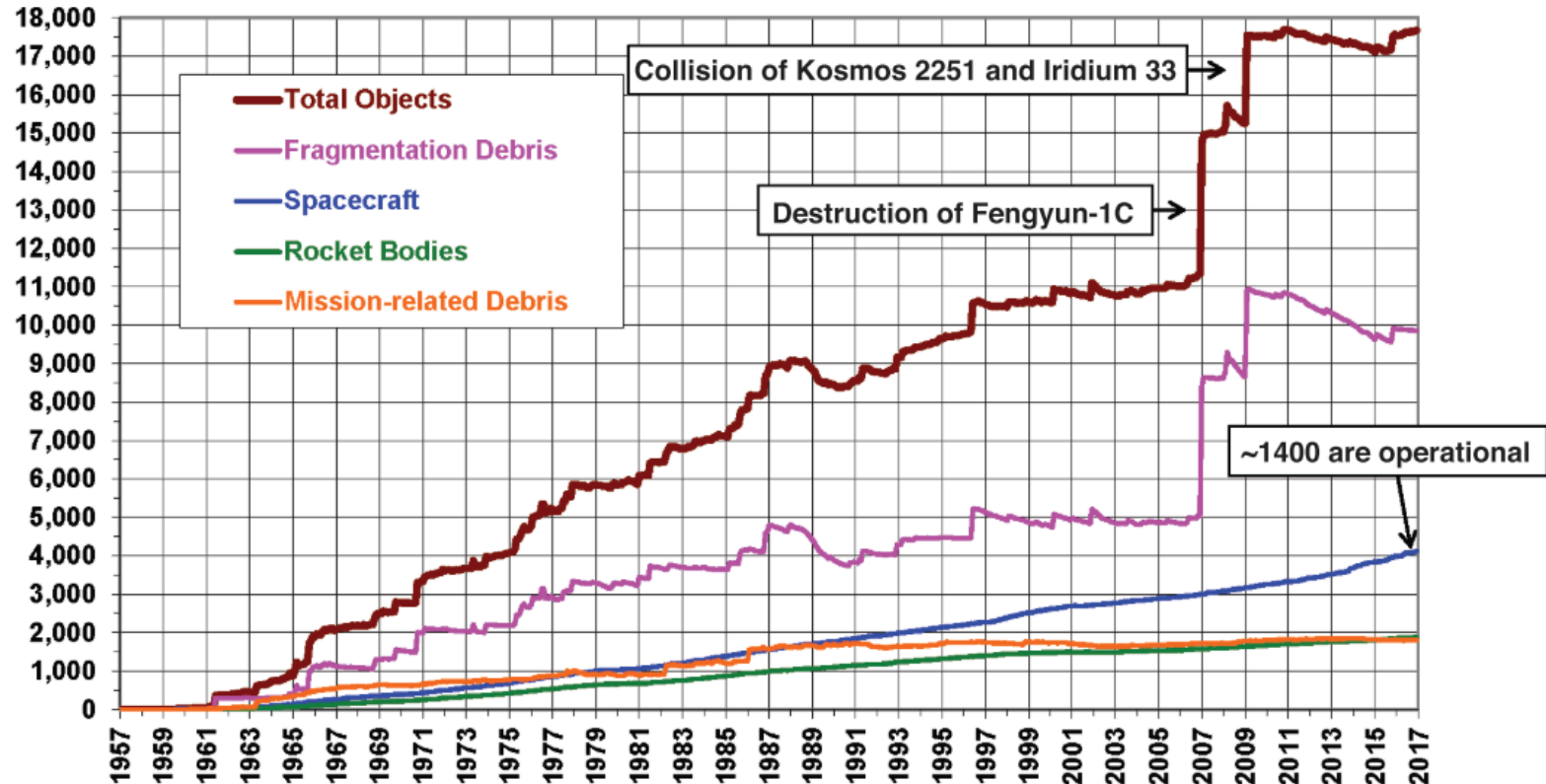
2) Anti-satellite weapons

- Conventional
- Nuclear
- Direct energy – radic
 - Jamming / disruptor

3) Cyber

- Only non-kinetic cap military operations

Figure 1.1 Growth in on-orbit population by category⁹



Small LEO space population largely unknown

LEO-crossing (0 to 2000 km) objects
estimated from debris surveys and events

167	>	5 m
350	>	4 m
721	>	3 m
1816	>	2 m
2879	>	1 m
3378	>	90 cm
4650	>	80 cm
5480	>	70 cm
6136	>	60 cm
6816	>	50 cm
7427	>	40 cm
8583	>	30 cm
13329	>	20 cm
18259	>	10 cm
23599	>	9 cm
28981	>	8 cm
34386	>	7 cm
39834	>	6 cm
45210	>	5 cm
50982	>	4 cm
77749	>	3 cm
211729	>	2 cm
364583	>	1 cm

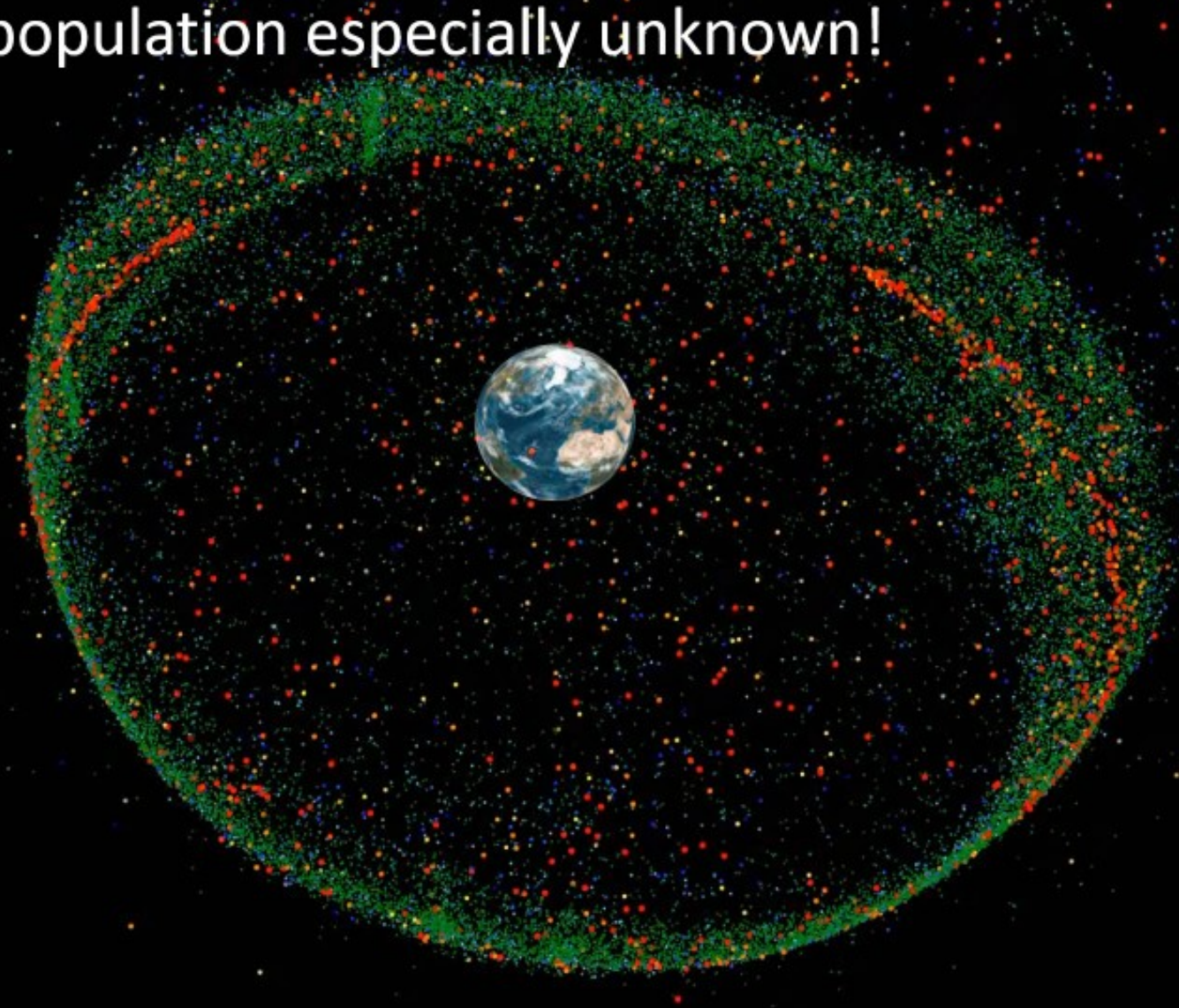
← Today's
public
catalog

Today's current public
catalog contains < 4% of
LEO-crossing objects > 1 cm

Small GEO space population especially unknown!

GEO-crossing ($\text{GEO} \pm 100 \text{ km}$) objects
estimated from debris surveys and events

634	>	5 m
783	>	4 m
960	>	3 m
1188	>	2 m
1378	>	1 m
1406	>	90 cm
1434	>	80 cm
1479	>	70 cm
1512	>	60 cm
1557	>	50 cm
1600	>	40 cm
1660	>	30 cm
1912	>	20 cm
2179	>	10 cm
2677	>	9 cm
3143	>	8 cm
3630	>	7 cm
4120	>	6 cm
4570	>	5 cm
5118	>	4 cm
7190	>	3 cm
17687	>	2 cm
33239	>	1 cm

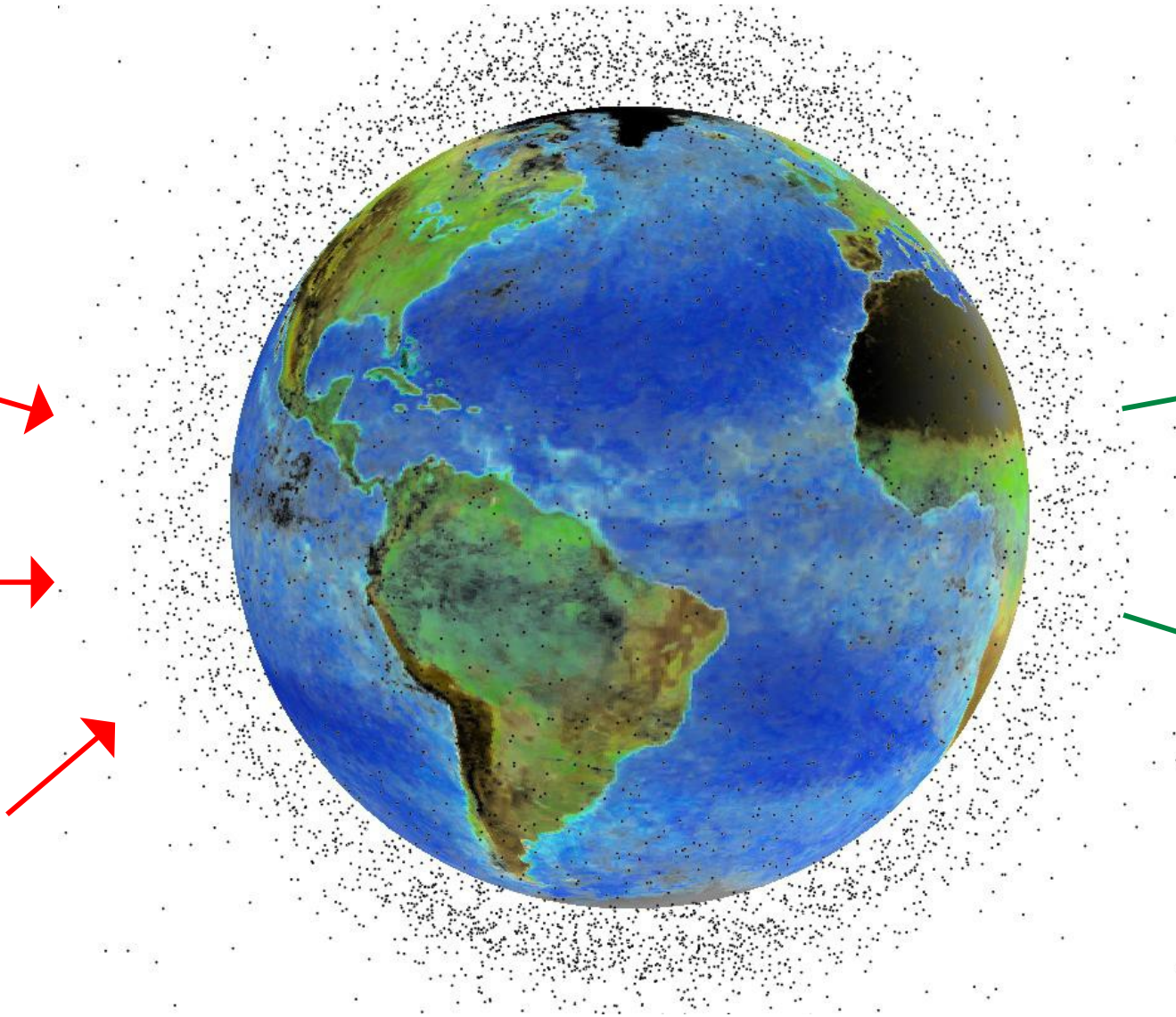


Sources

Launches (rocket bodies, payloads, mission related objects)

Fragmentations (explosions, collisions)

Non-fragmentation debris (surface degradation, solid rocket motor particles)



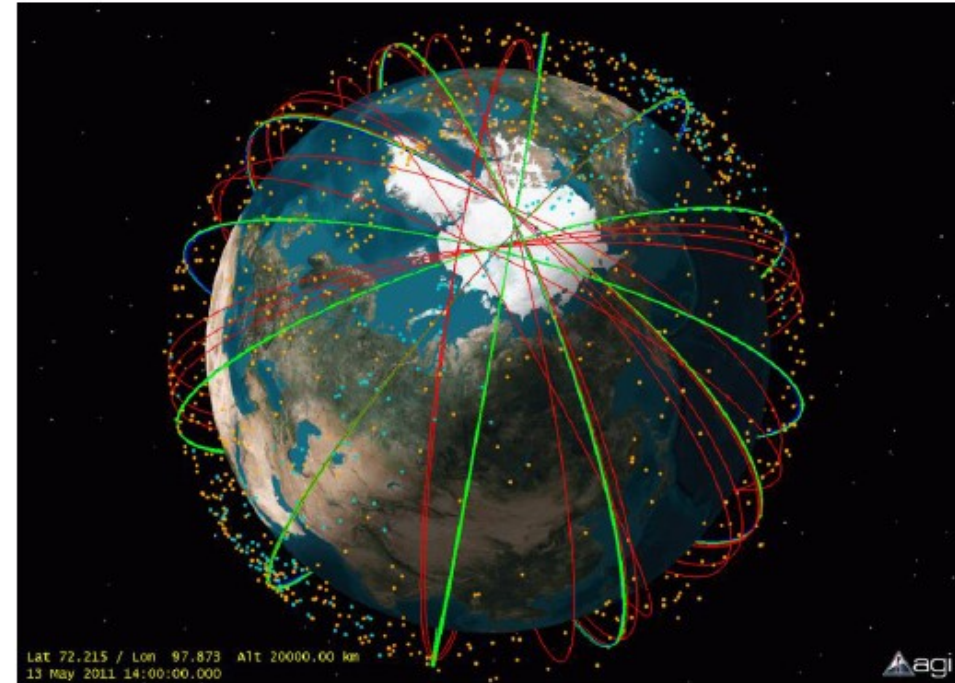
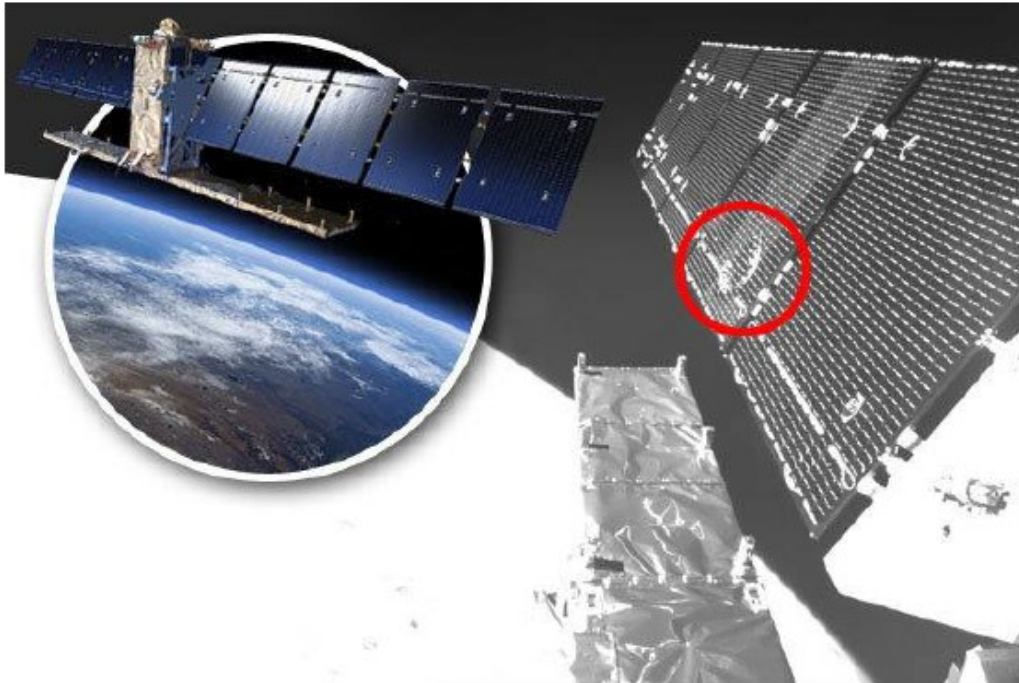
Sinks

Natural decay (atmospheric drag, solar radiation pressure, lunisolar perturbations)

Active Removal (de-orbit, non-propulsive maneuvers)

Space Debris

1. Space Surveillance & Tracking / Space Situational Awareness
 - radars and telescopes
2. Conjunction Assessment or Collision Avoidance (CA)
 - Based on ephemeris and a catalog of objects, predict potential collisions in space and inform operators (e.g. Sentinel 1A 2016) or Cosmos 2251 Iridium 33 [collision](#) 2009 Iridium Cosmos Satellite



Space Surveillance & Tracking / Space Situational Awareness

- Objects are detected and tracked/monitored by a range of radars and telescopes, military, civilian, commercial

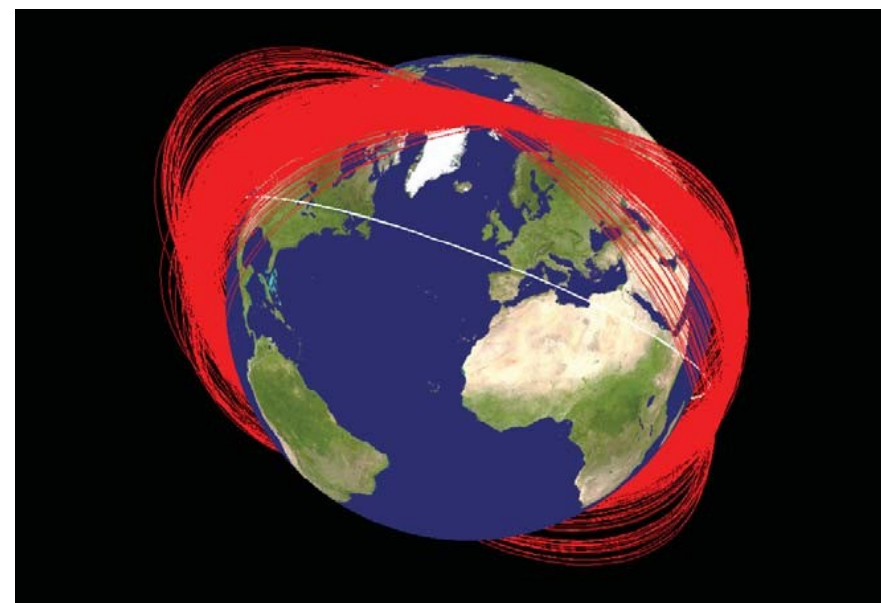




Starfish Prime
1962



SM-3 missile
2008



Fengyun-1C
2007

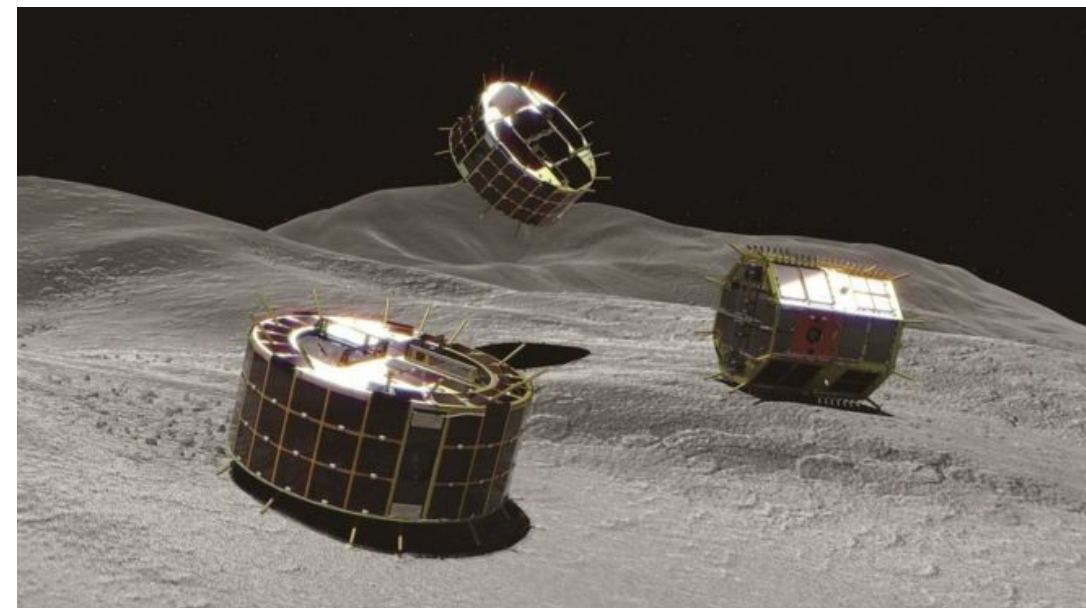
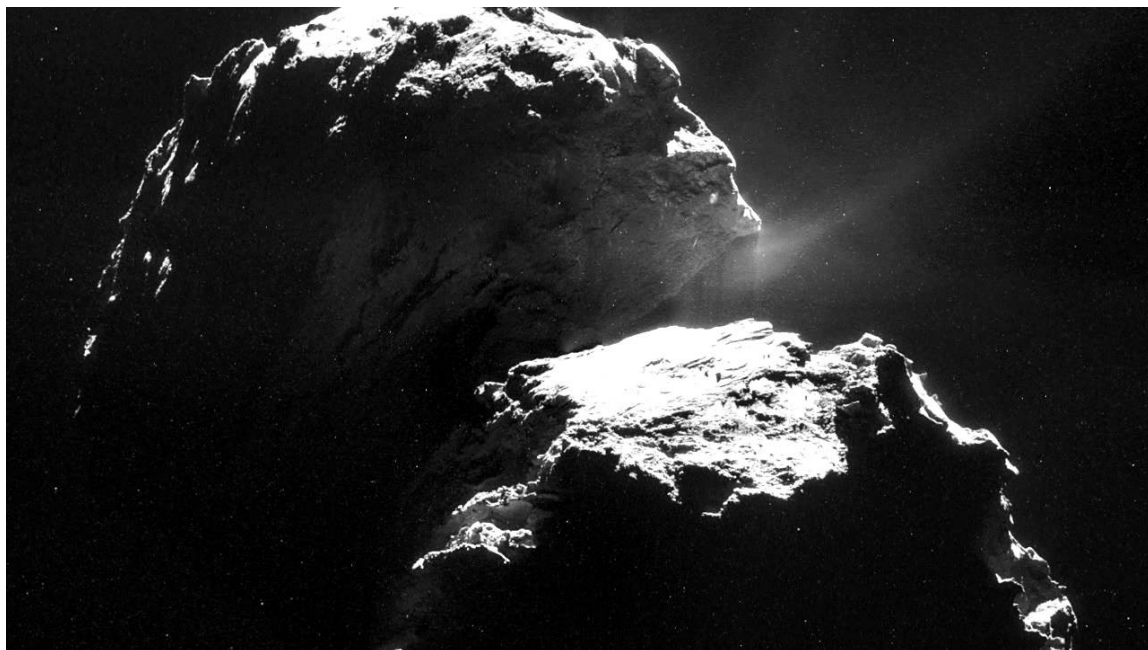
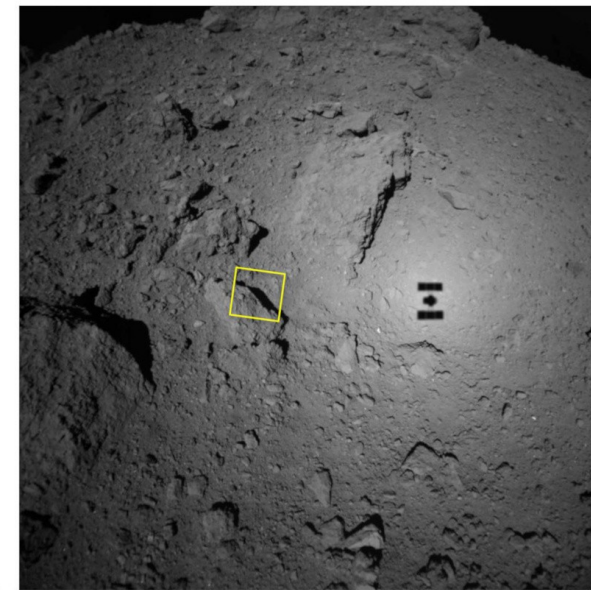
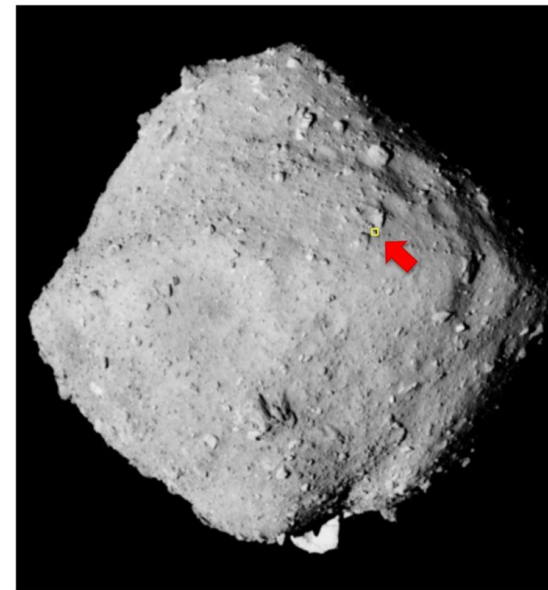
Current trends

- Privatisation + commercialisation
- Tourism
- Asteroid mining?
- Growing number of actors



NewSpace /
Space 4.0



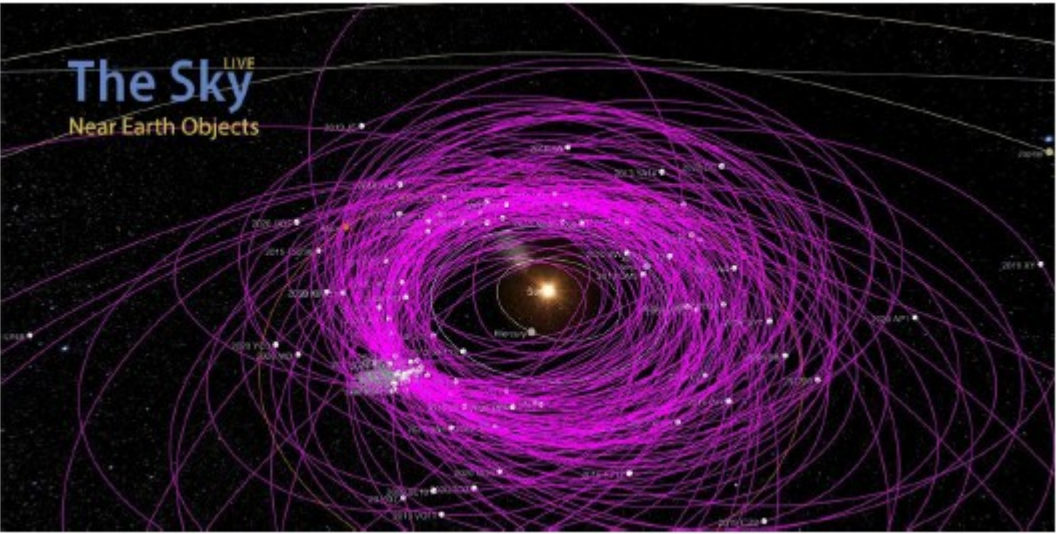


Rosetta Mission - a detailed study of comet

Hayabusa2 – asteroid sample return mission

DART - Double Asteroid Redirection Test

- <https://www.nasa.gov/press-release/nasa-s-dart-mission-hits-asteroid-in-first-ever-planetary-defense-test>
 - 10 months flying in space
 - Sept. 26 - targeted the asteroid moonlet Dimorphos, a small body just 160 meters in diameter.
 - It orbits a larger, 780-meter asteroid called Didymos. Neither asteroid poses a threat to Earth.
 - Prior to DART's impact, it took Dimorphos 11 hours and 55 minutes to orbit its larger parent asteroid, Didymos. Since DART's intentional collision with Dimorphos on Sept. 26, astronomers have been using telescopes on Earth to measure how much that time has changed. Now, the investigation team has confirmed the spacecraft's impact altered Dimorphos' orbit around Didymos by 32 minutes, shortening the 11 hour and 55-minute orbit to 11 hours and 23 minutes



NewSpace

- Technological progress = large amount of actors and assets
 - Cheaper development, production and operation of satellites and launchers
- Various industrial sectors - such as IT companies, investment and media companies
- New approaches, emphasis on innovation, lowering the overall price due to competition
- Products are not perfect but sufficient
 - Priority is given to a lower price before a perfect performance, reliability and endurance
- More efficient and simpler manufacturing processes
 - Cheaper components, 3D printing, open source software, adaptable production model

What topics to follow?

- Private sector
- Legal system
- Miniaturization – microsattelites
- Evolution of autonomous systems
- Antisatellites system
- Planetary Defence
- Fifth NATO operational domain



- http://spacesecurityindex.org/ssi_editions/space-security-2019/
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- https://edition.cnn.com/2020/10/31/us/psyche-asteroid-ultraviolet-trnd-sc/index.html?utm_source=fbCNNi&utm_content=2020-10-31T15%3A09%3A31&utm_medium=social&utm_term=link&fbclid=IwAR19p6YUeNxxv4B8Vv7fWfgDbpIlt8I55LSgBrAPq31f4wa48AJuRXIkzaOQ
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