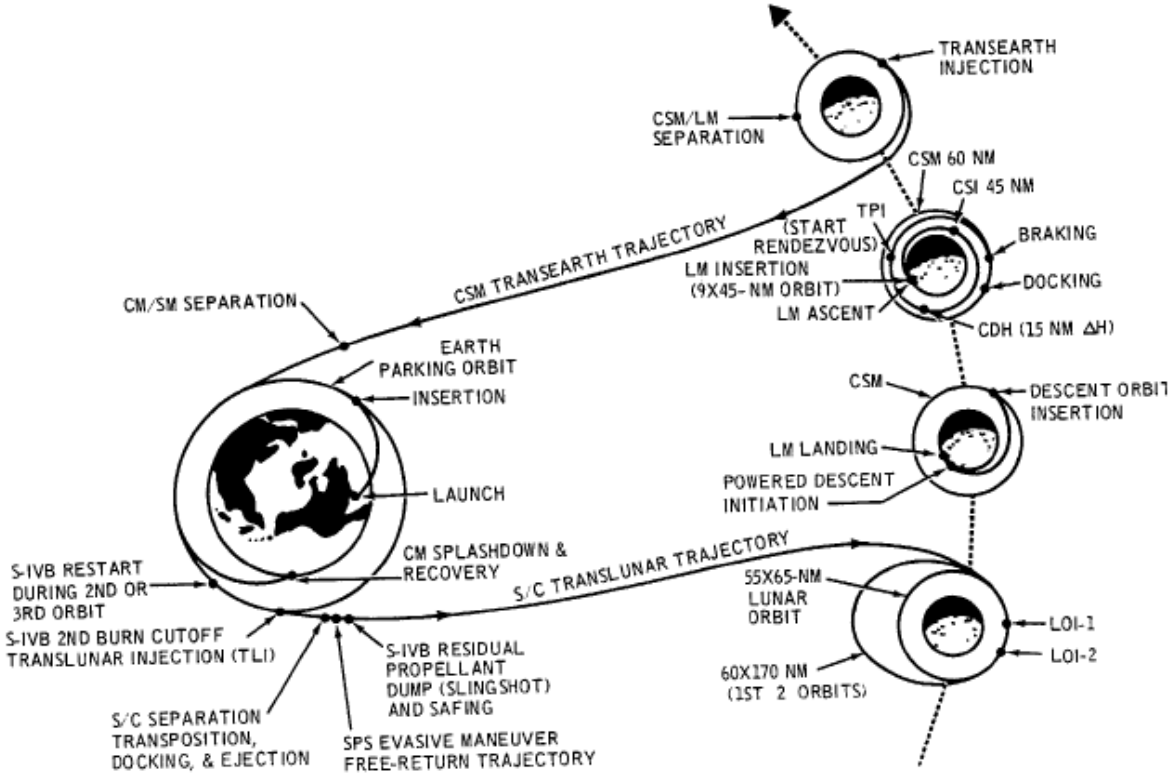
Modern Technologies and Conflicts

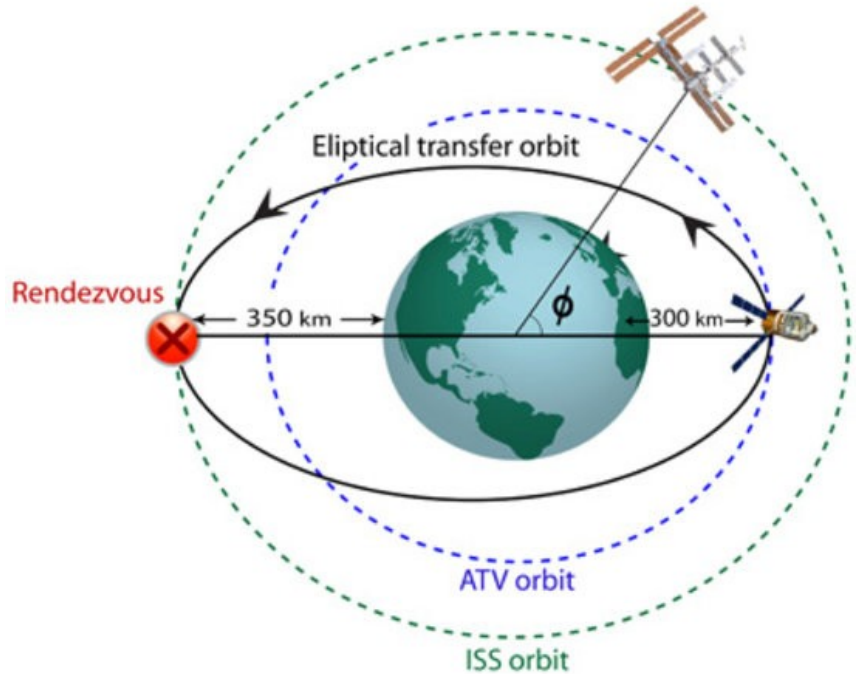
Space Security

23.10.2024

Marek Dvořáček


Canada


TRANSEARTH INJECTION
CSM/LM SEPARATION
CSM 60 NM
CSI 45 NM
TPI (START RENDEZVOUS)
BRAKING
DOCKING
LM INSERTION (9X45-NM ORBIT)
LM ASCENT
CDH (15 NM ΔH)
CSM TRANSEARTH TRAJECTORY
CM/SM SEPARATION
EARTH PARKING ORBIT
INSERTION
CSM
DESCENT ORBIT INSERTION
LM LANDING
POWERED DESCENT INITIATION
LAUNCH
CM SPLASHDOWN & RECOVERY
S/C TRANSLUNAR TRAJECTORY
S-IVB RESTART DURING 2ND OR 3RD ORBIT
55X65-NM LUNAR ORBIT
LOI-1
LOI-2
S-IVB 2ND BURN CUTOFF TRANSLUNAR INJECTION (TLI)
S-IVB RESIDUAL PROPELLANT DUMP (SLINGSHOT) AND SAFING
60X170 NM (1ST 2 ORBITS)
S/C SEPARATION TRANSPOSITION, DOCKING, & EJECTION
SPS EVASIVE MANEUVER FREE-RETURN TRAJECTORY


Eliptical transfer orbit
Rendezvous
350 km
ϕ
300 km
ATV orbit
ISS orbit


VVO

- 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

Future spaceflights [edit]

Scheduled future flights are shown below:

Spacecraft	ISS Flight No.	Mission	Launcher	Scheduled date (UTC)[85][86][87]
SpaceX CRS-31	CRS SpX-31	Logistics	Falcon 9 Block 5	30 October 2024
Progress MS-29	ISS-90P	Logistics	Soyuz 2.1a	21 November 2024
SpaceX CRS-32	CRS SpX-32	Logistics	Falcon 9 Block 5	December 2024
Cygnus NG-22	CRS NG-22	Logistics	Falcon 9 Block 5	February 2025
Progress MS-30	ISS-91P	Logistics	Soyuz 2.1a	12 February 2025
SpaceX CRS-33	CRS SpX-33	Logistics	Falcon 9 Block 5	March 2025
HTV-X1	HTV-X1	Logistics	H3-24W	March 2025
SNC Demo-1	ISS-SNC-1	Logistics	Vulcan Centaur VC4L	May 2025
Progress MS-31	ISS-92P	Logistics	Soyuz 2.1a	May 2025
Cygnus NG-23	CRS NG-23	Logistics	Antares 300	Late 2025
SpaceX CRS-34	CRS SpX-34	Logistics	Falcon 9 Block 5	Late 2025
Progress MS-32	ISS-93P	Logistics	Soyuz 2.1a	August 2025
Progress MS-33	ISS-94P	Logistics	Soyuz 2.1a	October 2025
Progress MS-34	ISS-95P	Logistics	Soyuz 2.1a	February 2026
Cygnus NG-24	CRS NG-24	Logistics	Antares 300	Early 2026
SpaceX CRS-35	CRS SpX-35	Logistics	Falcon 9 Block 5	Early 2026
Progress MS-35	ISS-96P	Logistics	Soyuz 2.1a	May 2026
Cygnus NG-25	CRS NG-25	Logistics	Antares 300	Late 2026
Progress MS-36	ISS-97P	Logistics	Soyuz 2.1a	August 2026
Progress MS-37	ISS-98P	Logistics	Soyuz 2.1a	October 2026
US Deorbit Vehicle	?	Deorbit	?	2030

expedition [edit]

h	Crew	Arrival (UTC)	Arrival Flight	Departure (UTC)	Departure Flight	Duration (days)
	Matthew Dominick Michael Barratt Jeanette Epps Alexander Grebenkin	Transferred from Expedition 71		October 2024 (planned)	SpaceX Crew-8	
	Aleksey Ovchinin Ivan Vagner Donald Pettit			March 2025 (planned)	Soyuz MS-26	
	Barry E. Wilmore *Sunita Williams*[note 9]			February 2025 (planned)	SpaceX Crew-9	
	Nick Hague Aleksandr Gorbunov	29 September 2024 21:30	SpaceX Crew-9			
	Anne McClain Nichole Ayers Takuya Onishi Kirill Peskov	February 2025 (planned)	SpaceX Crew-10	Will be transferred to Expedition 73		
	Sergey Ryzhikov Alexey Zubritsky Jonny Kim	March 2025 (planned)	Soyuz MS-27			

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Space junk cou

May 31, 2017

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AKTUALIZOVÁNO

Slovenská policie 27. s vraždy novináře J

čtvrtek ráno o tom informoval slovenský Den

DISCOVER VIDEO BIG THINK FOR BUSINESS

big think Smarter Faster

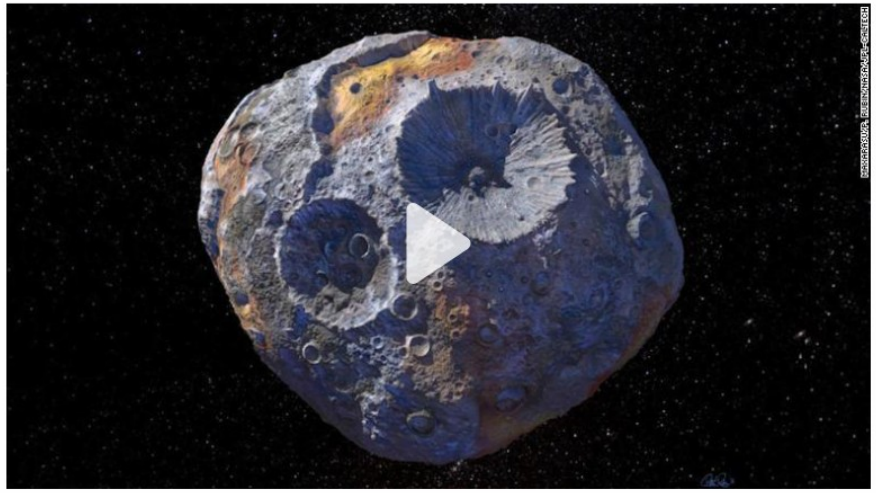
How the Kessler Syndrome can end

CNN US Crime + Justice Energy + Environment Extreme Weather Space + Science Edition

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

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.

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the US with a space attack,

The Guardian International edition

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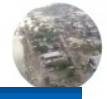
Indonesia tsunami: death toll could reach thousands, officials say



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

dporujeme

Analyses Sections Forums

Omar Lamrani focuses on air

MARKETS BUSINESS INVESTING TECH POLITICS CNBC TV INVESTING CLUB PRO

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 L3
- Viasat is selling its "Link 16 Tactica communications system that conn through a secured voice and data

SPACENEWS

As DoD grows more reliant o the relationship

by Sandra Erwin — September 22, 2022

DoD and the intelligence commu they would use commercial spac

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

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es Iran of jamming its

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 Vasylkiv 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'

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

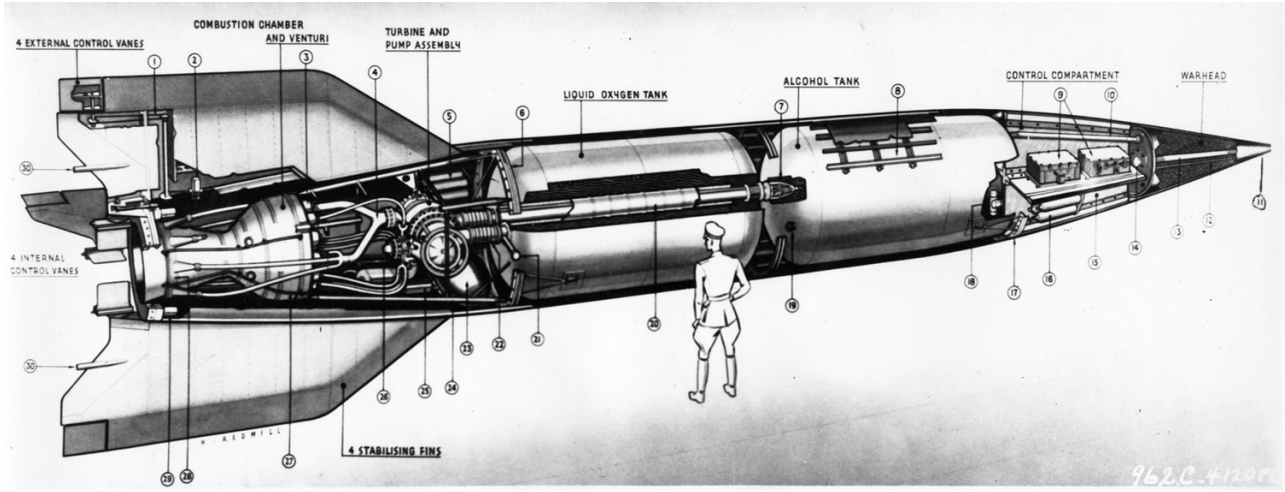
- the highest achievable point for ordinary aviation: Aeronautics

- 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)*

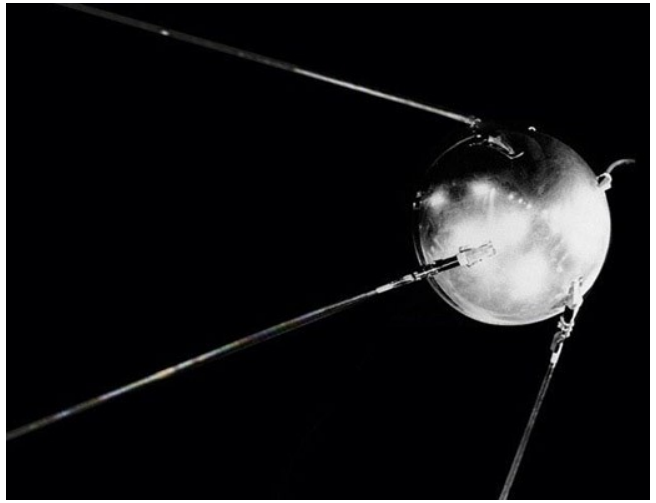
2) history – 1942

- Vergeltungswaffe 2

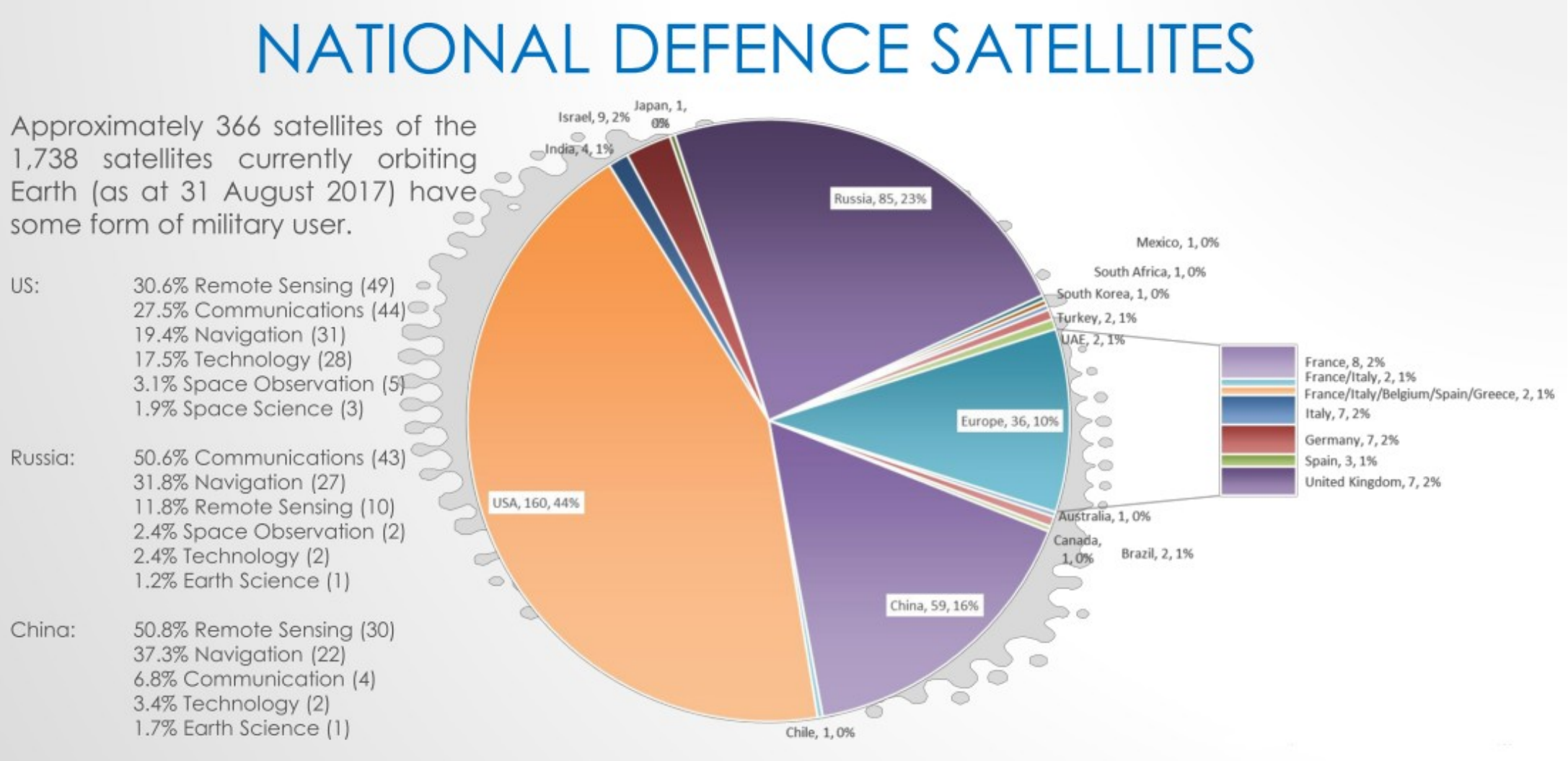


- 1957

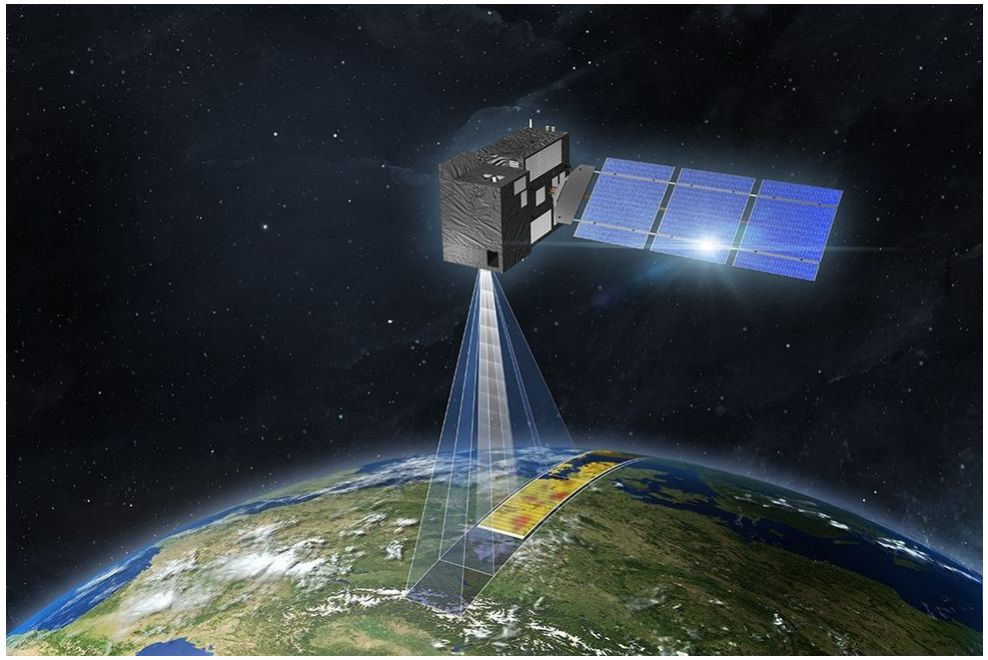
Sputnik-1



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)
Israel, 9, 2%
Japan, 1, 0%
India, 4, 1%
Russia, 85, 23%
Mexico, 1, 0%
South Africa, 1, 0%
South Korea, 1, 0%
Turkey, 2, 1%
UAE, 2, 1%
Europe, 36, 10%
France, 8, 2%
France/Italy, 2, 1%
France/Italy/Belgium/Spain/Greece, 2, 1%
Italy, 7, 2%
Germany, 7, 2%
Spain, 3, 1%
United Kingdom, 7, 2%
USA, 160, 44%
Australia, 1, 0%
Canada, 1, 0%
Brazil, 2, 1%
China, 59, 16%
Chile, 1, 0%

Satellites



REPORTS & MULTIMEDIA / FEATURE

UCS Satellite Database

In-depth details on the 7,560 satellites currently orbiting Earth, including their country of origin, purpose, and other operational details.

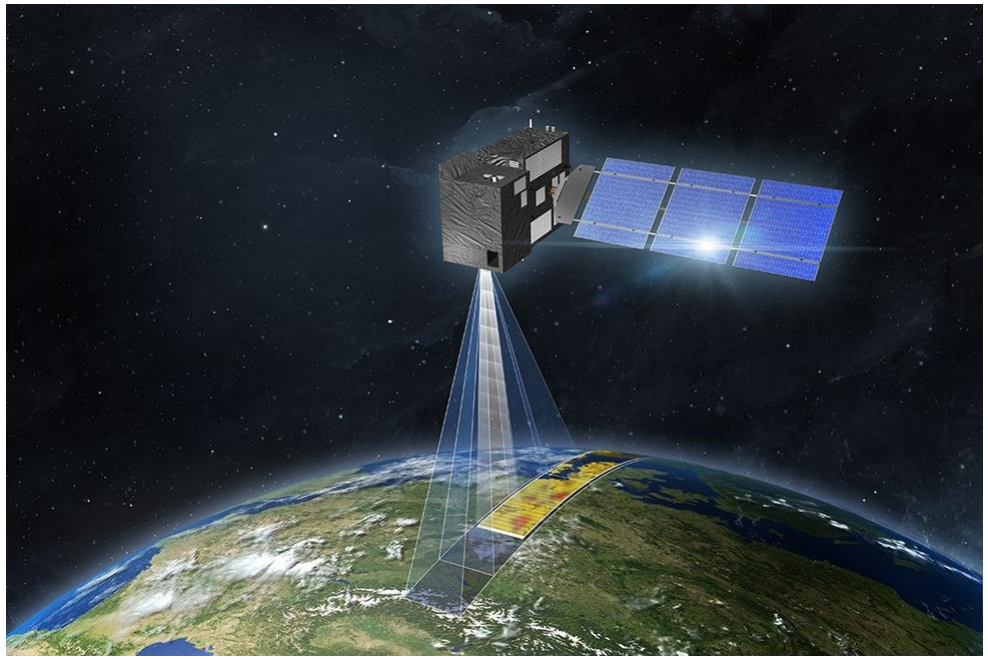
Published Dec 8, 2005 | Updated May 1, 2023

Satellite quick facts

Includes launches through **5/1/2023**

- **Total number of operating satellites: 7,560**
  - United States: 5,184
  - Russia: 181
  - China: 628
  - Other: 1,572
- LEO: 6,768
- MEO: 143
- Elliptical: 59
- GEO: 590
- **Total number of US satellites: 5,184**
  - Civil: 30
  - Commercial: 4,741
  - Government: 167
  - Military: 246

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

GeoInt

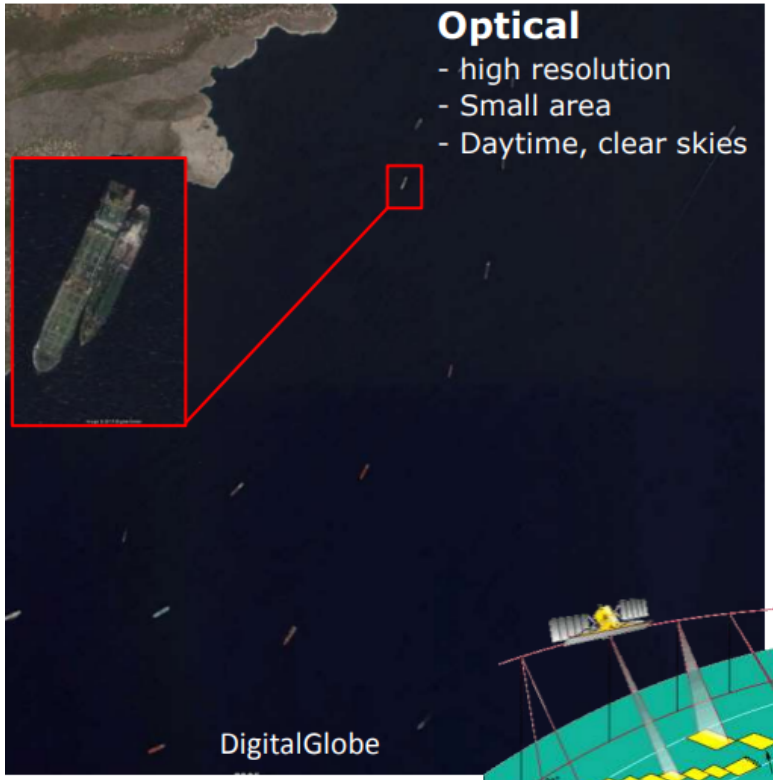
Table 1: *Space effects and possible sources (not an all-inclusive list)*

Space Services	NATO Uses and Effects	National and Commercial Systems
Position, Navigation, Timing (PNT)	• Precision strike • Force navigation • Support to PR/CSAR • Network timing	• Global Positioning System (US) • Galileo (EU)
Integrated Tactical Warning and Threat Assessment	• Force protection • Attribution • Missile defence	• Space Based Infrared System (US)
Environmental Monitoring	• Mission planning • Munitions selection • Weather forecasting	• Defence Meteorological Satellite Program (US) • EUMETSAT (EU)
Communications	• Command and Control • Unmanned Aerial Vehicle ops • Deployed communications	• GBS (US) • Syracuse (FRA) • EUTELSAT (FRA) • SICRAL (ITA) • SKYNET (UK) • INTELSAT (US)
Intelligence, Surveillance and Reconnaissance	• Coverage of operation execution (in the operations centre) • Battle Damage Assessment (BDA) • Intelligence • Targeting	• SAR Lupe (DEU) • COSMO SKYMED (ITA) • HELIOS (FRA) • IKONOS (?)(US)
Identification	• Automated Identification	• AIS

Earth observation satellites

European Commission

➔ Used for **recognition**



➔ Used for **detection**

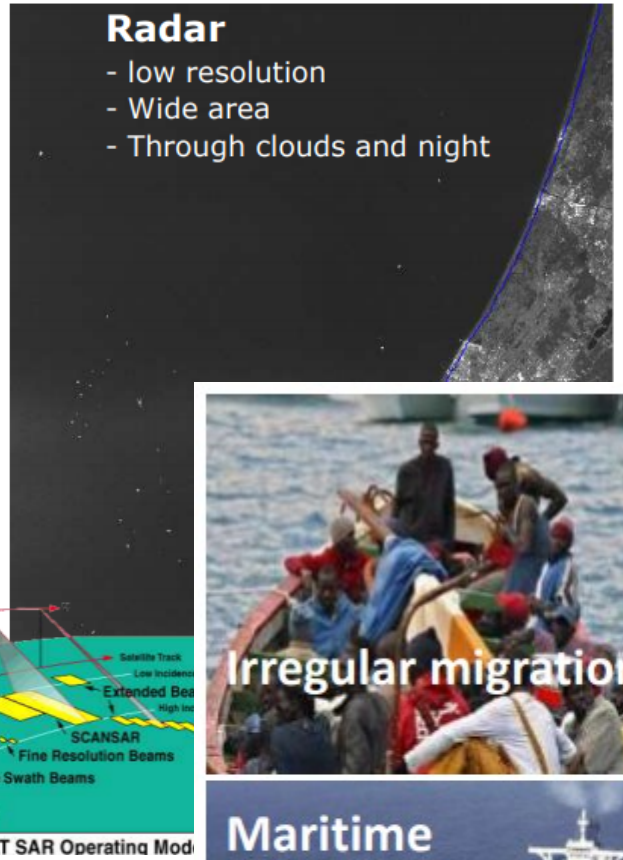
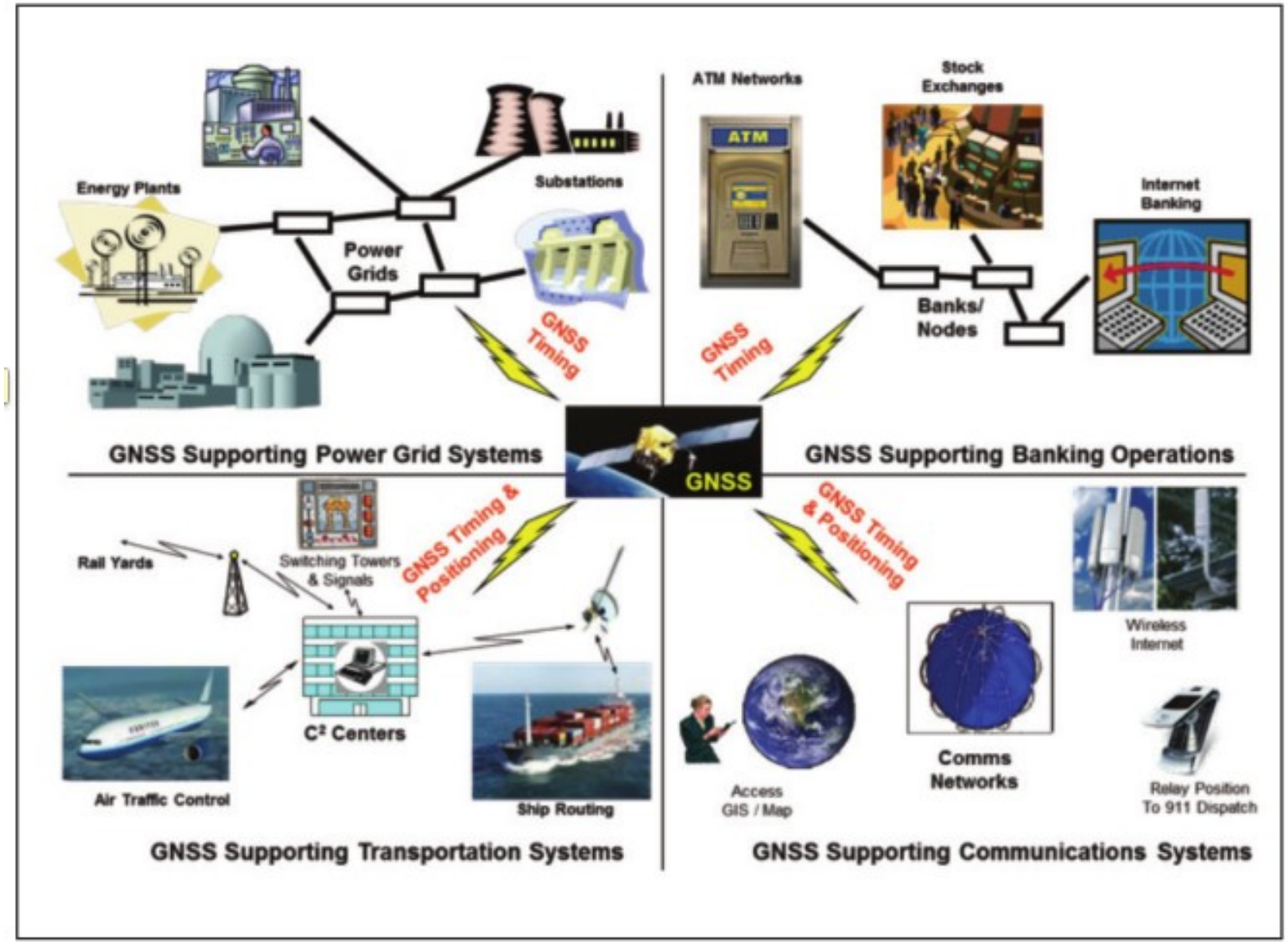
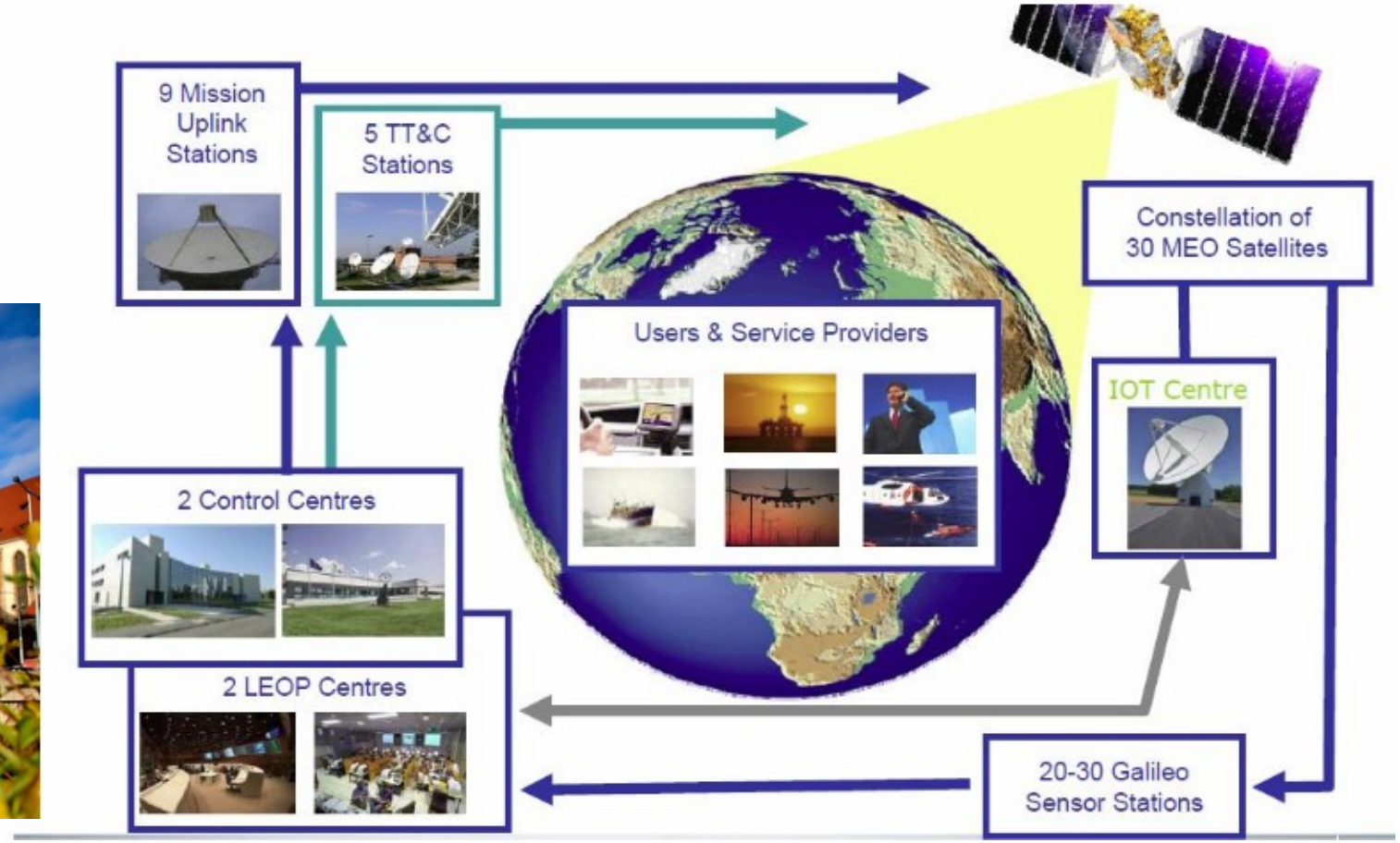


Figure 5: Today's reliance on GNSS positioning and timing signals



EUSPA
European Union Agency for the Space Programme



Copernicus

https://www.youtube.com/watch?v=MGJss4lDaBo

- 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

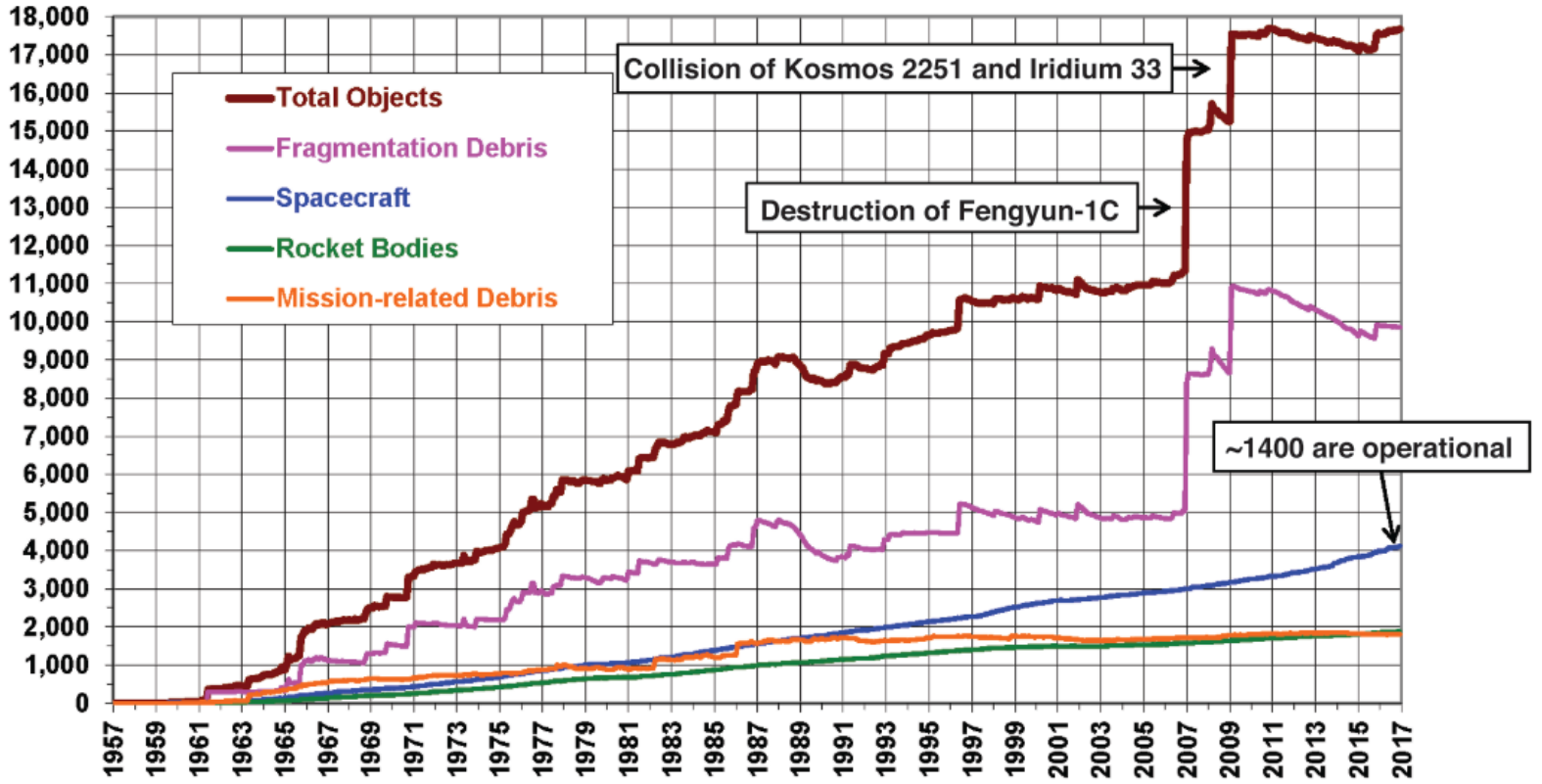
1) Space debris
   - Kessler syndrome

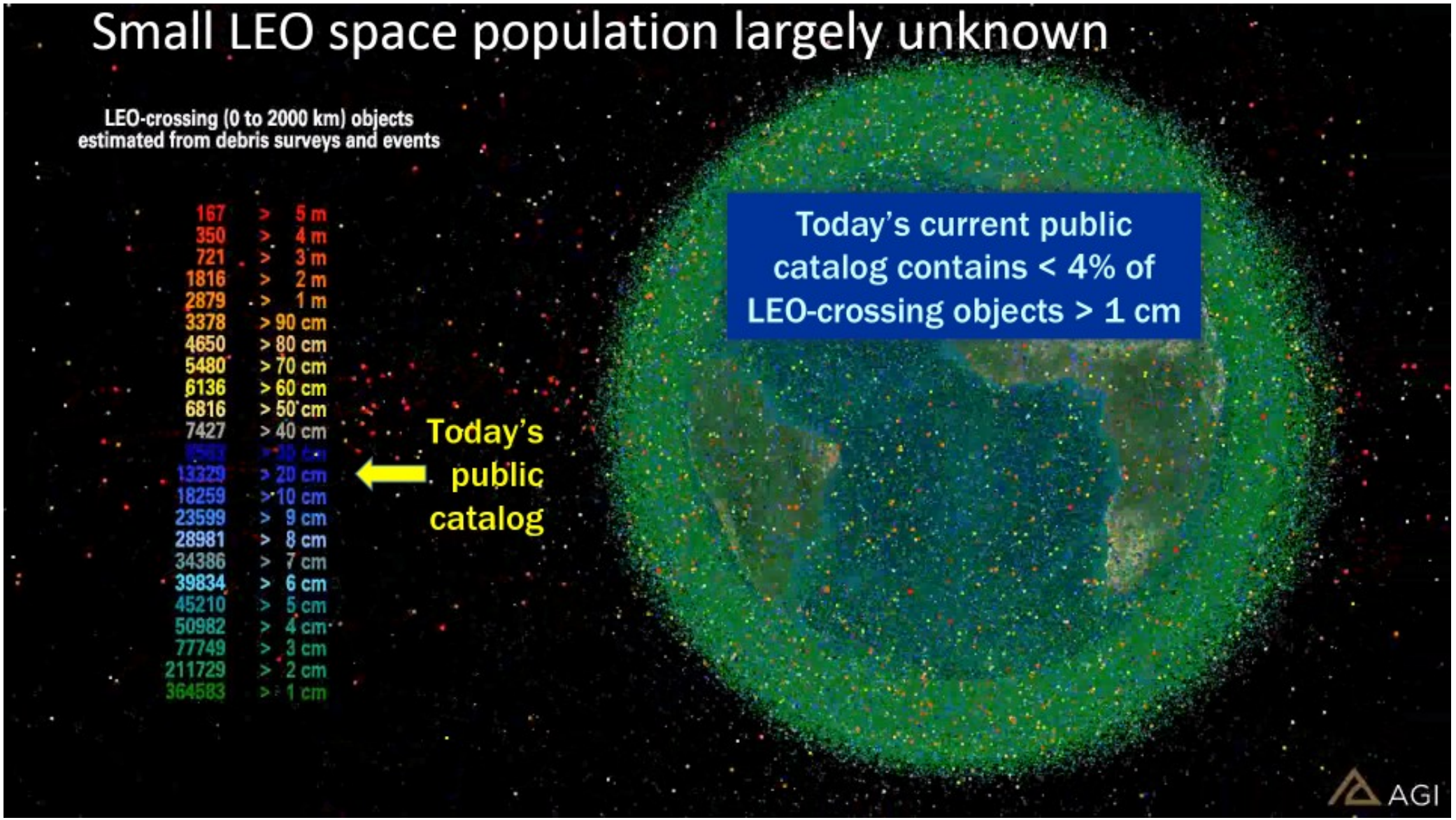
2) Anti-satellite weapo
   - Conventional
   - Nuclear
   - Direct energy – radic
     - Jamming / disruptior

3) Cyber

- Only non-kinetic cap
  military operations

Figure 1.1 Growth in on-orbit population by category[9]

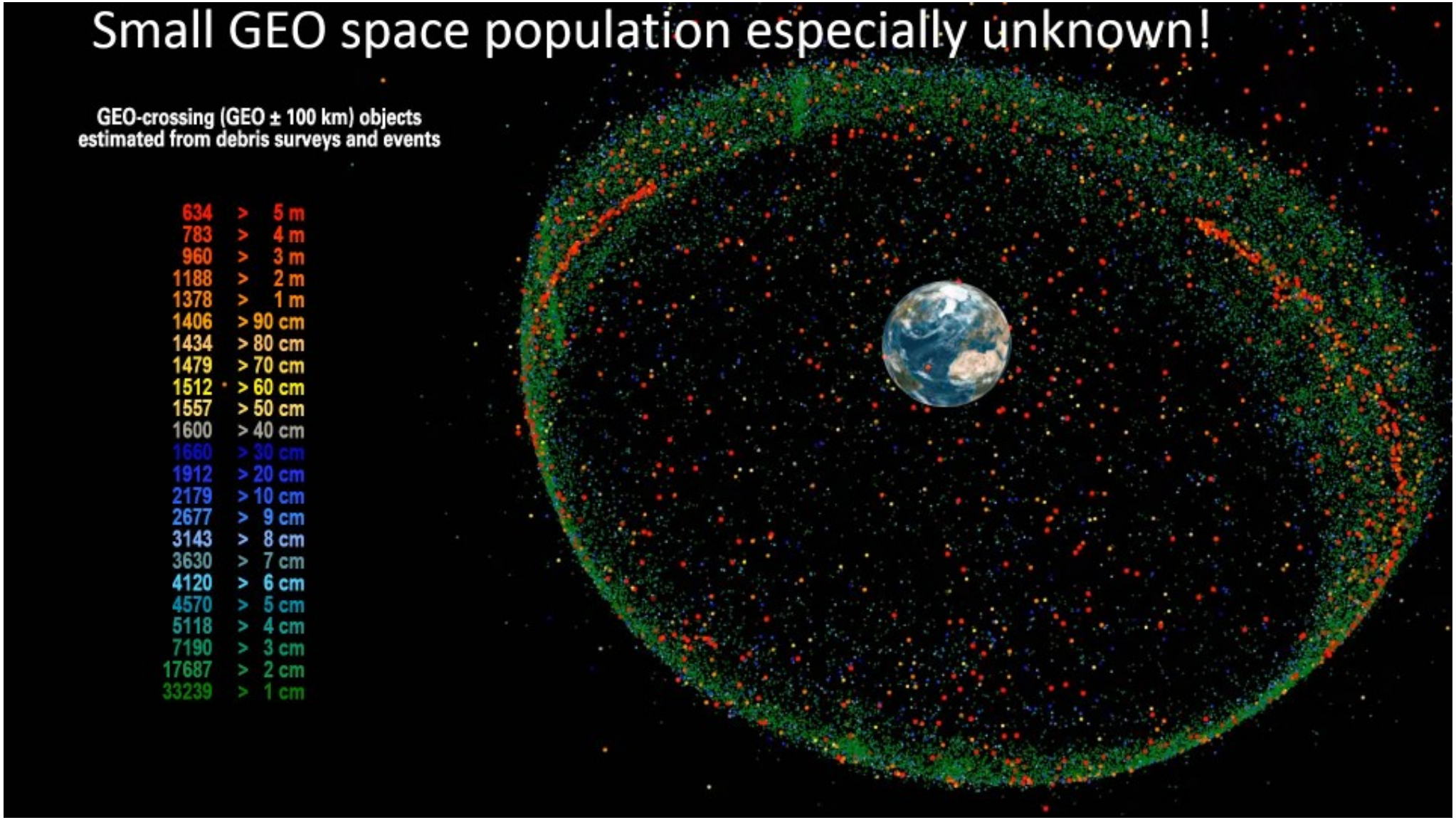



Small LEO space population largely unknown
LEO-crossing (0 to 2000 km) objects
estimated from debris surveys and events
167 > 5 m
350 > 4 m
721 > 3 m
1816 > 2 m
2879 > 1 m
3378 > 90 cm
4650 > 80 cm
5480 > 70 cm
6136 > 60 cm
6816 > 50 cm
7427 > 40 cm
13329 > 20 cm
18259 > 10 cm
23599 > 9 cm
28981 > 8 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
AGI

Small GEO space population especially unknown!

GEO-crossing (GEO ± 100 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

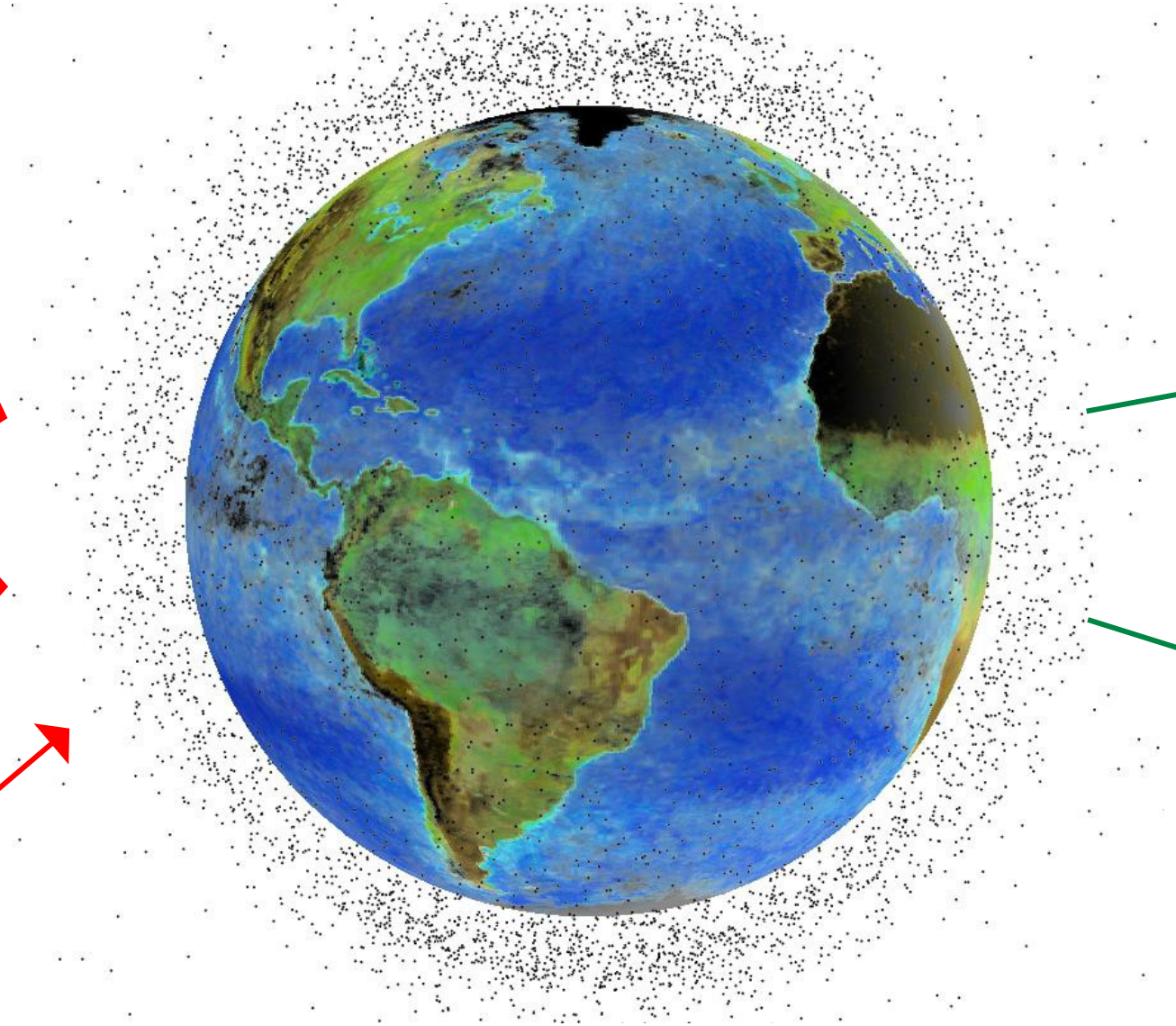


Sources

Launches (rocket bodies, payloads, mission related objects)

Fragmentations (explosions, collisions)

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



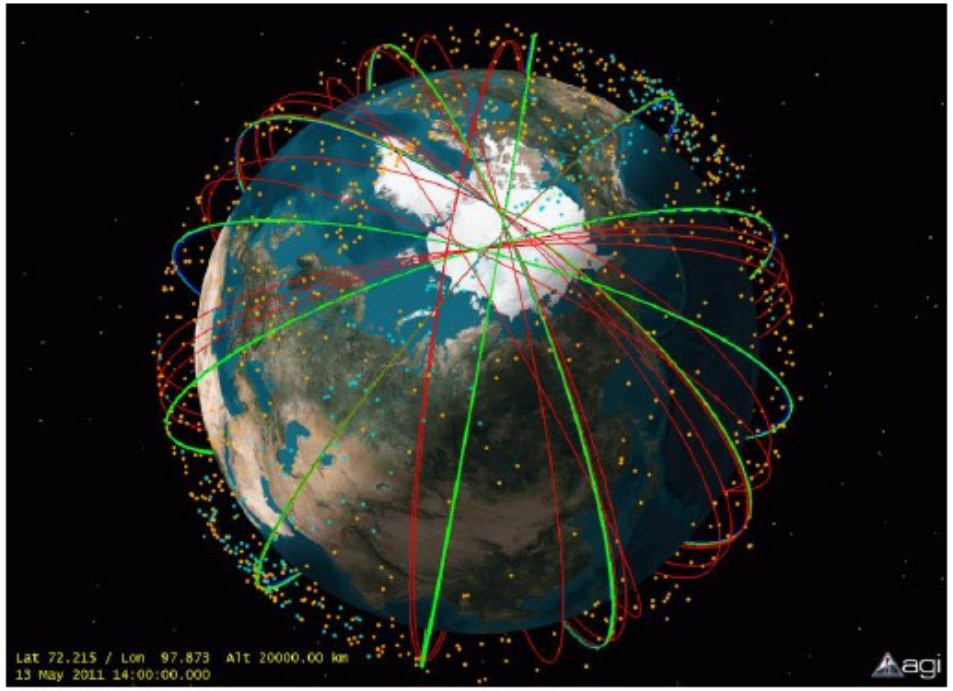
Sinks

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

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

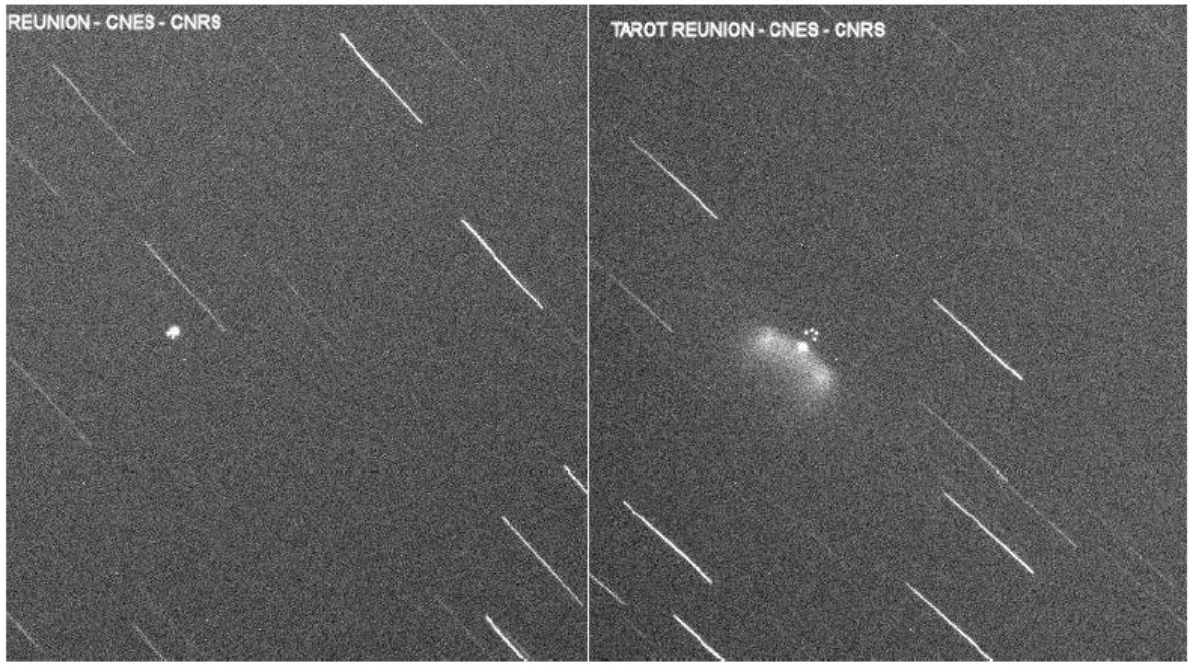
Space Debris

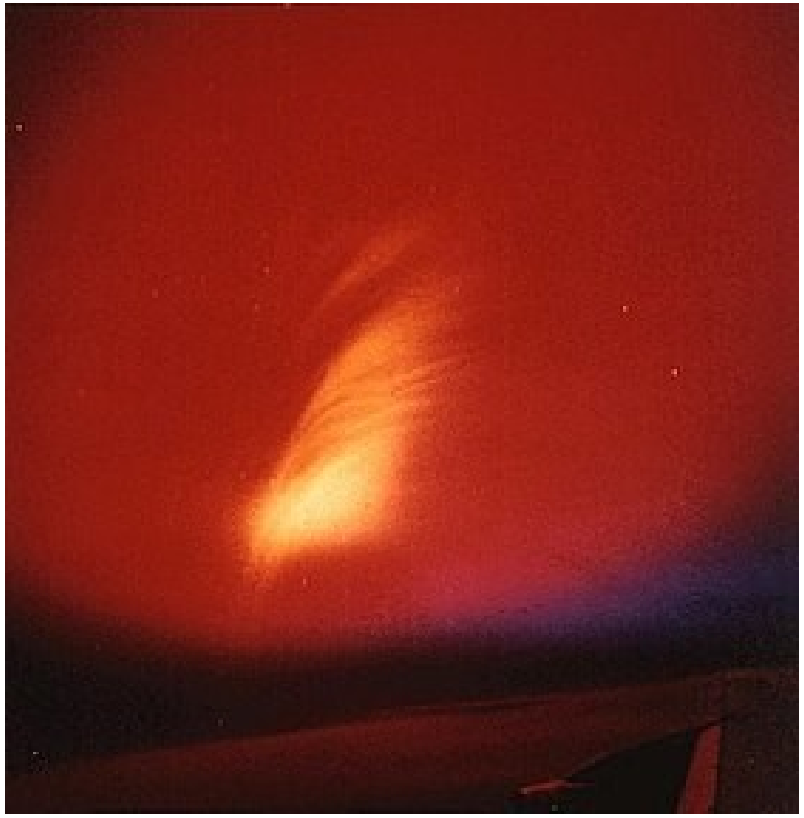
1. Space Surveillance & Tracking / Space Situational Awareness
   - radars and telescopes
2. Conjunction Assessment or Collision Avoidance (CA)
   - Based on ephemeris and a catalog of objects, predict potential collisions in space and inform operators (e.g. Sentinel 1A 2016) or Cosmos 2251 Iridium 33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



Space Surveillance & Tracking / Space Situational Awareness

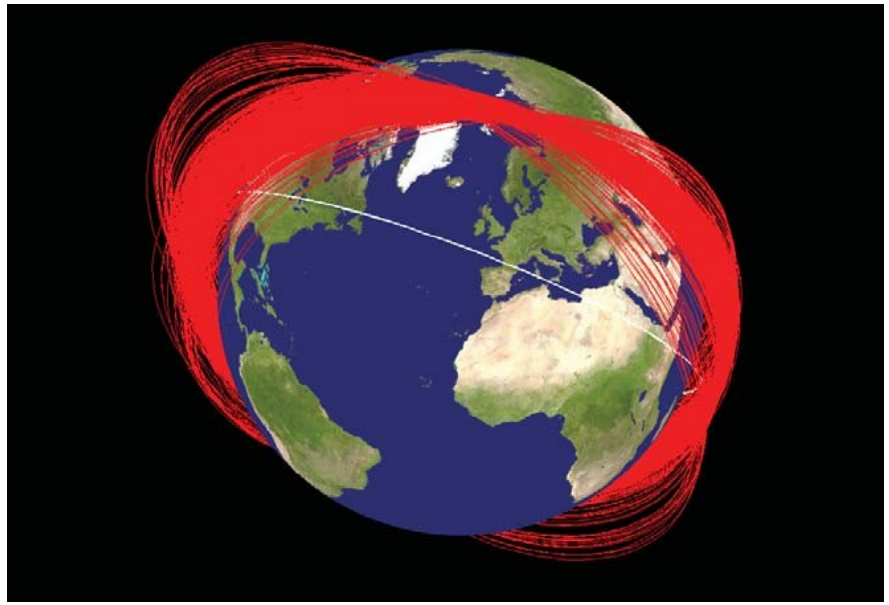
- Objects are detected and tracked/monitored by a range of radars and telescopes, military, civilian, commercial





Starfish Prime
1962

SM-3 missile
2008

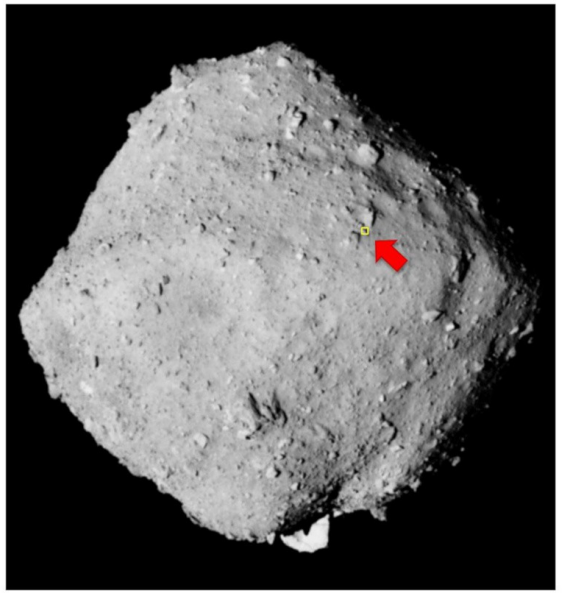


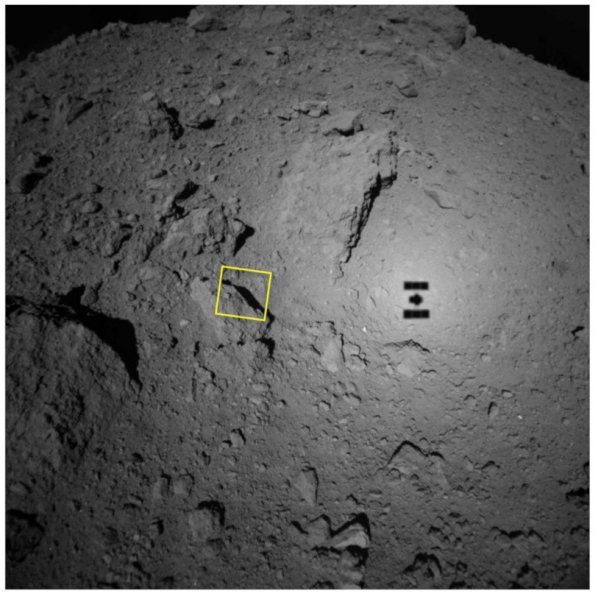
Fengyun-1C
2007

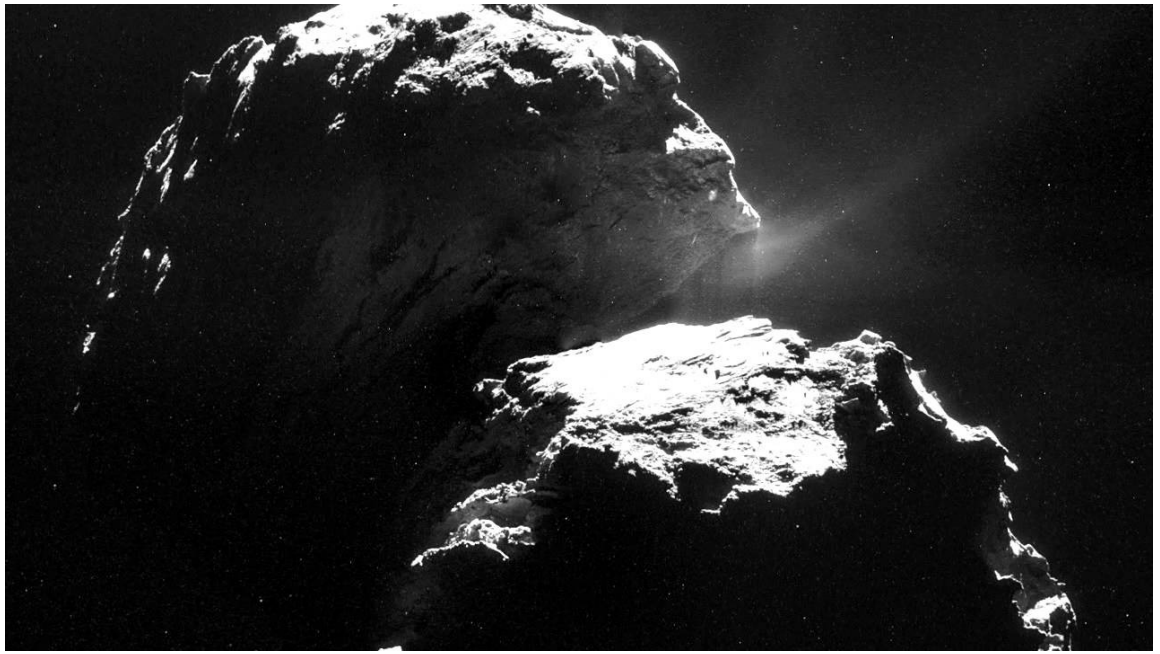
Current trends

- Privatisation + commercionalisation
- Turism
- Asteroid mining?
- Growing number of actors

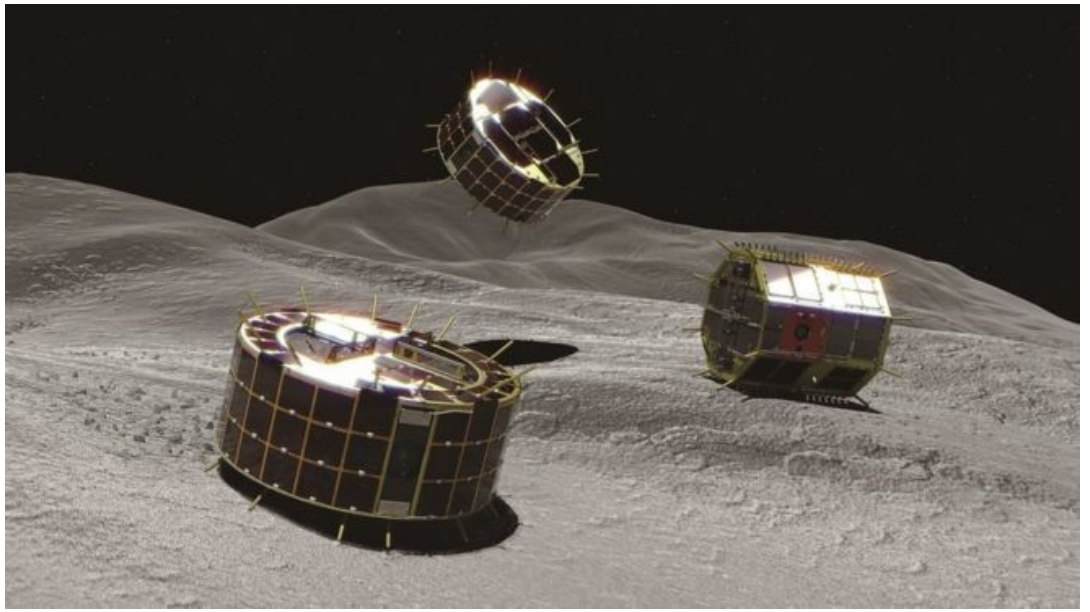
NewSpace / Space 4.0







Rosetta Mission - a detailed study of comet



Hayabusa2 – asteroid sample return mission

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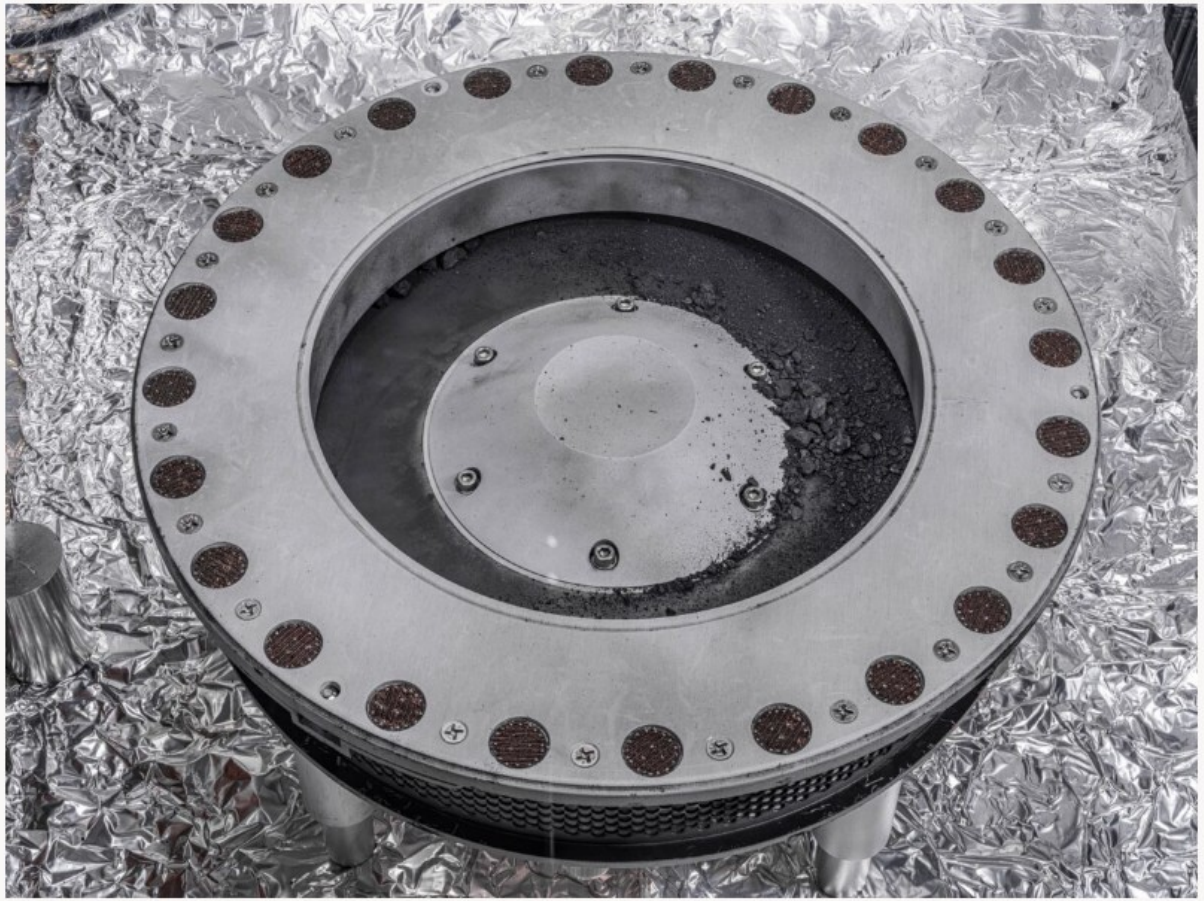
Civil

Scientists excited by first look at OSIRIS-REx asteroid samples

Jeff Foust October 12, 2023



- Asteroid Bennu
- Start 2016, collection 2020, September 2023 return to Earth
- 250 grams material, goal of mission was 60 grams

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 – microsatellites
- Evolution of autonomous systems
- Antisatellites system
- Planetary Defence
- Fifth NATO operational domain

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