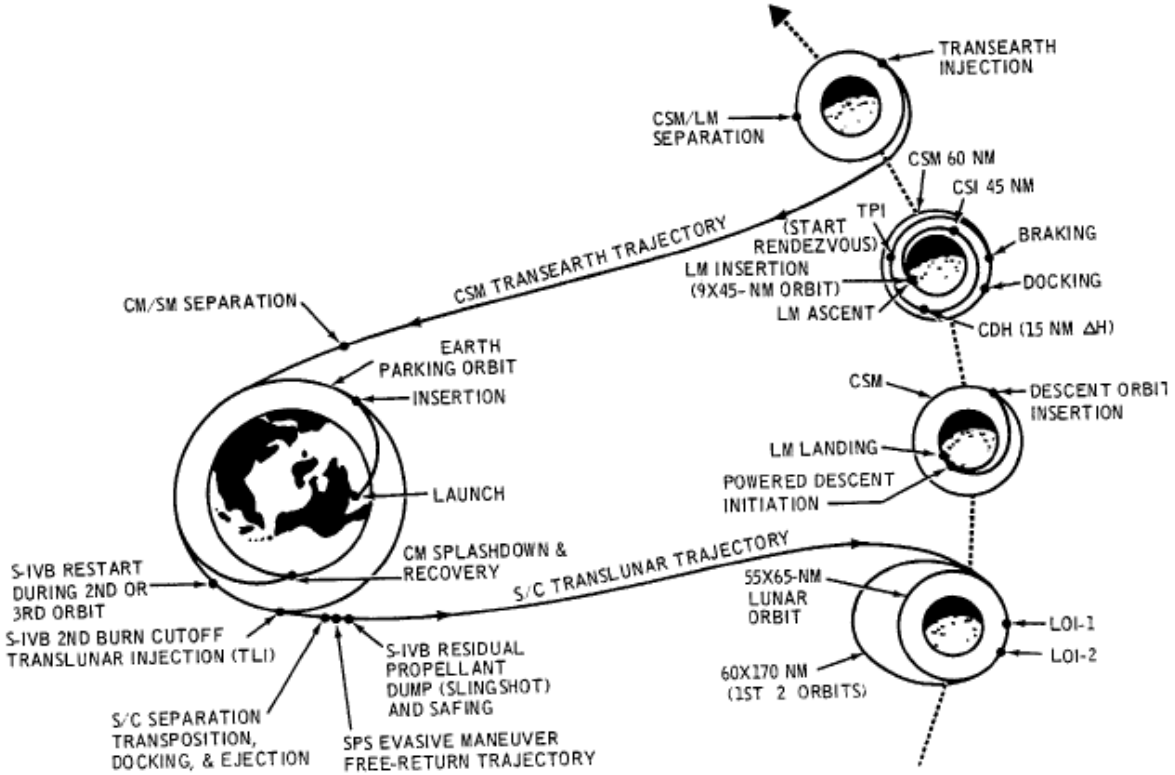
Modern Technologies and Conflicts

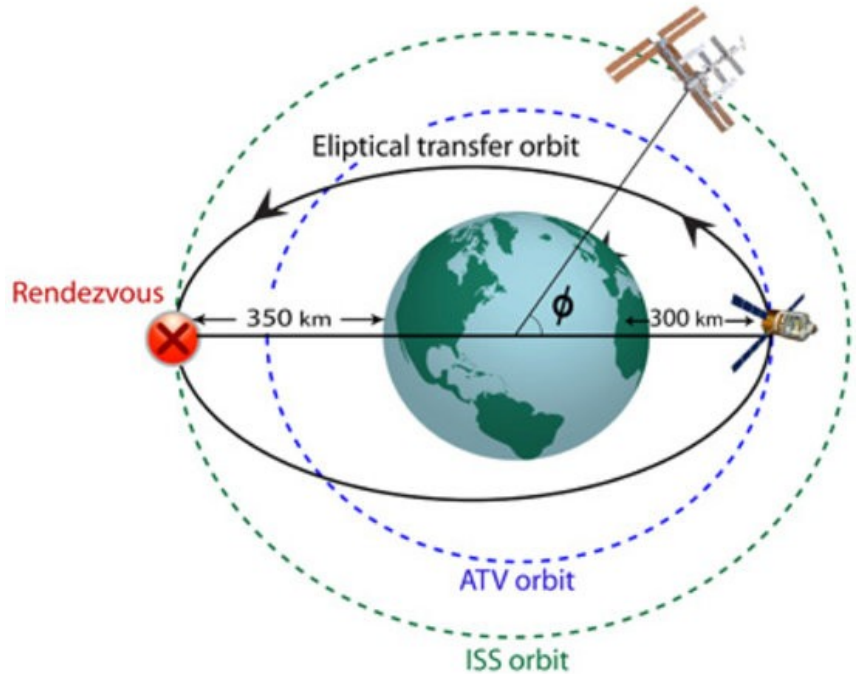
Space Security

16.10.2019

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


PARMITANO
СКВОРЦОВ
MORGAN
СКРИПОЧКА
MEIR
KOCH
LXI

PHYS.ORG Nanotechnology Physics

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

Space junk could destr

May 31, 2017

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DISCOVER VIDEO BIG THINK FOR BUSINESS

big think Smarter Faster

How the Kessler Syndrome can end all space exploration and destroy modern life

An increasingly likely catastrophe can cause major disruptions in space flight and our daily lives.

PAUL RATNER 29 August, 2018

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.

IFE | ALL PRIME | INTELLIGENCE

the US with a space attack,

The Guardian International edition

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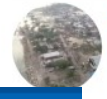


Live Tsunami in Indonesia: death toll at 832 and expected to rise sharply – live updates

dporujeme

Analyses Sections Forums

Omar Lamrani focuses on air

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

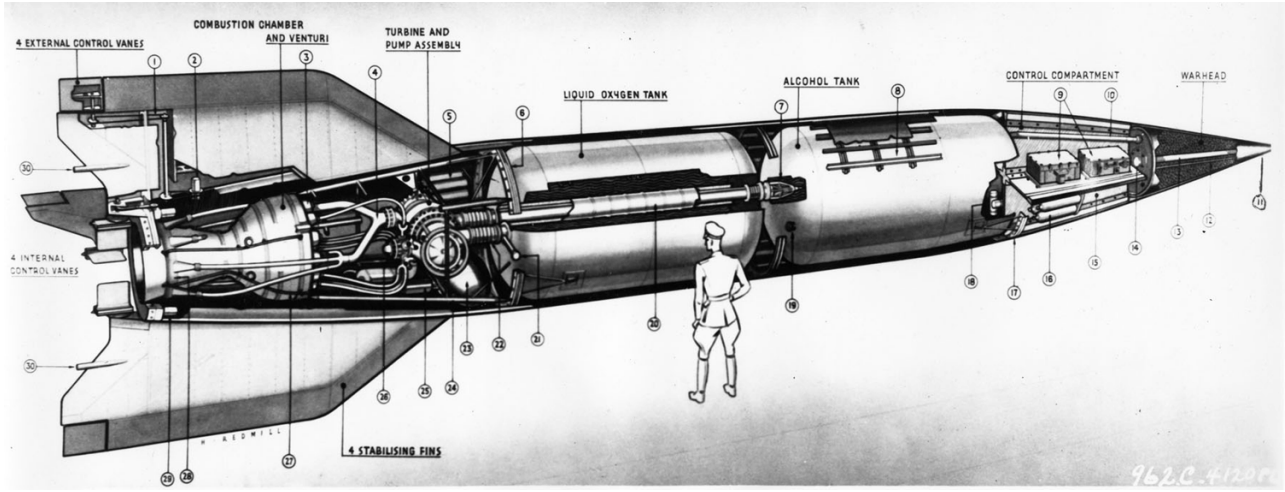
- the highest achievable point for ordinary aviation: Aeronautics

- 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)*

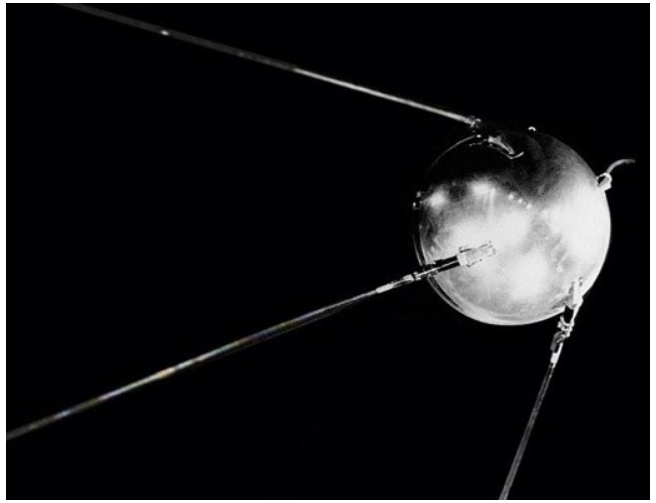
2) history – 1942

- Vergeltungswaffe 2

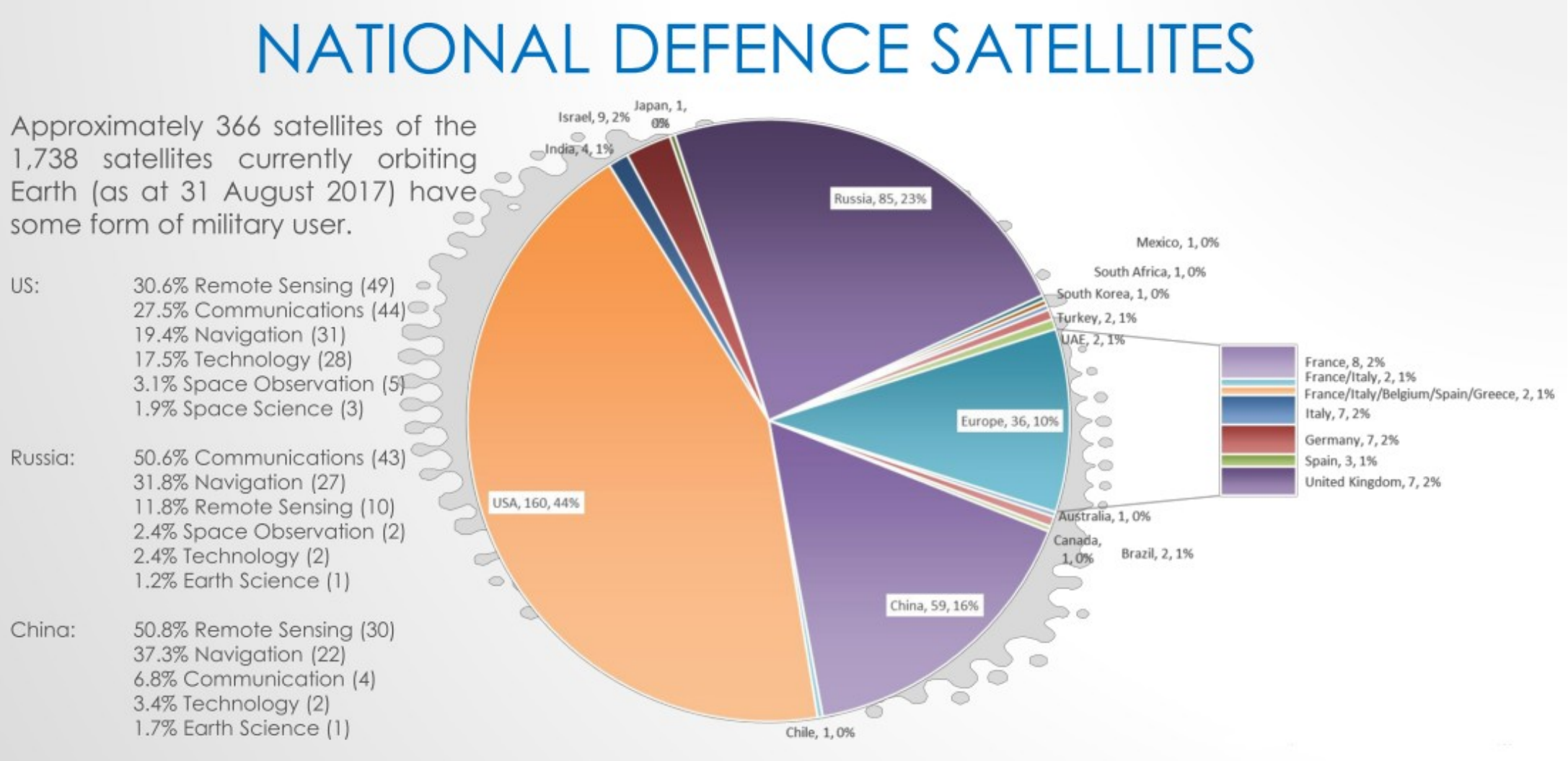


- 1957

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%

GeoInt

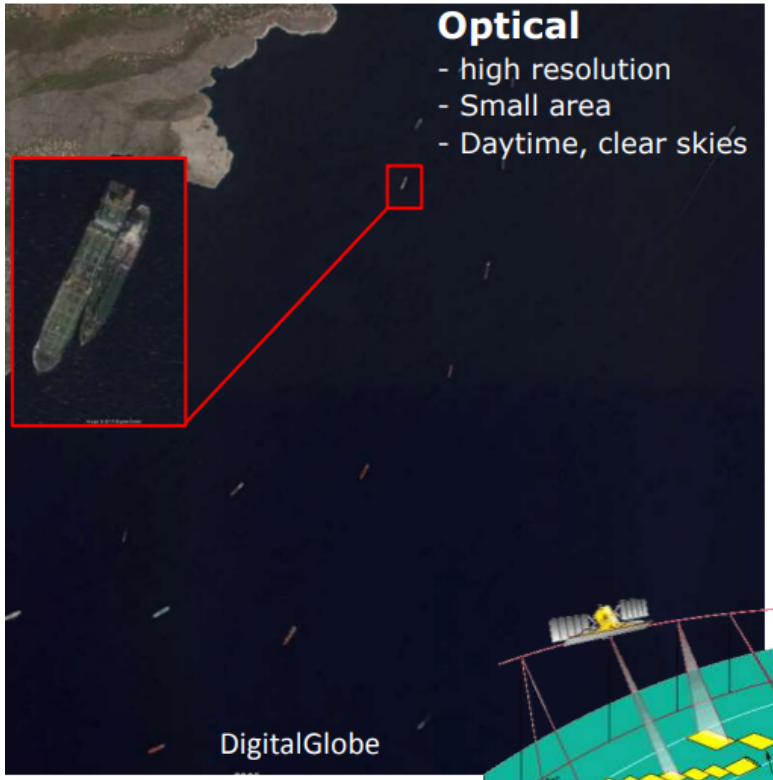
Table 1: *Space effects and possible sources (not an all-inclusive list)*

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**

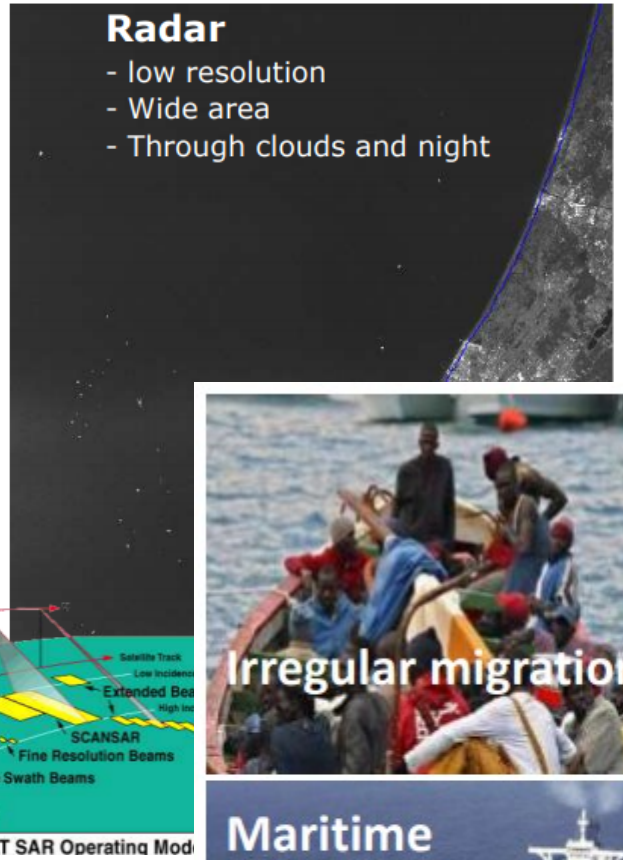
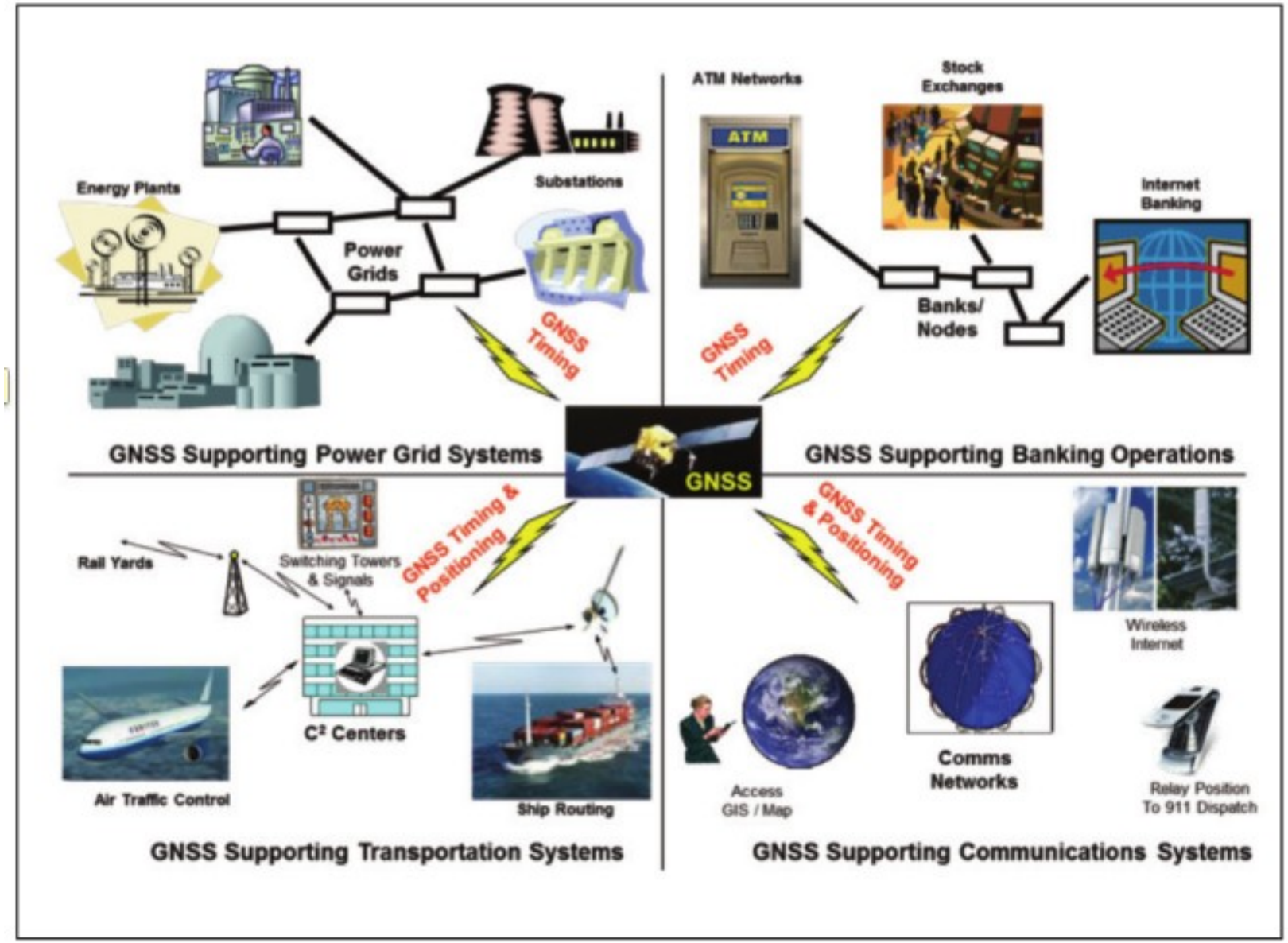


Figure 5: Today's reliance on GNSS positioning and timing signals



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

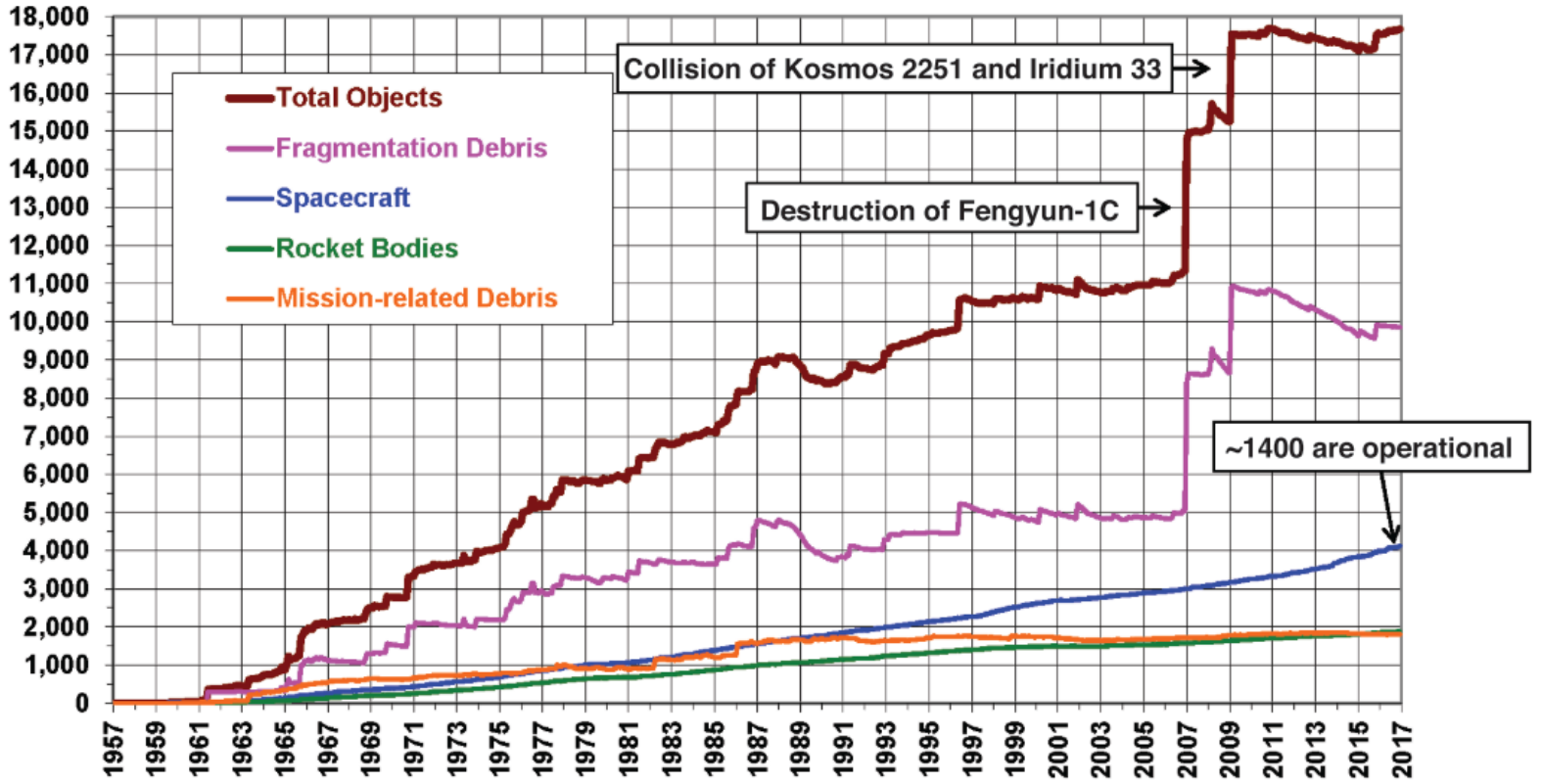
1) Space debris
   - Kessler syndrome

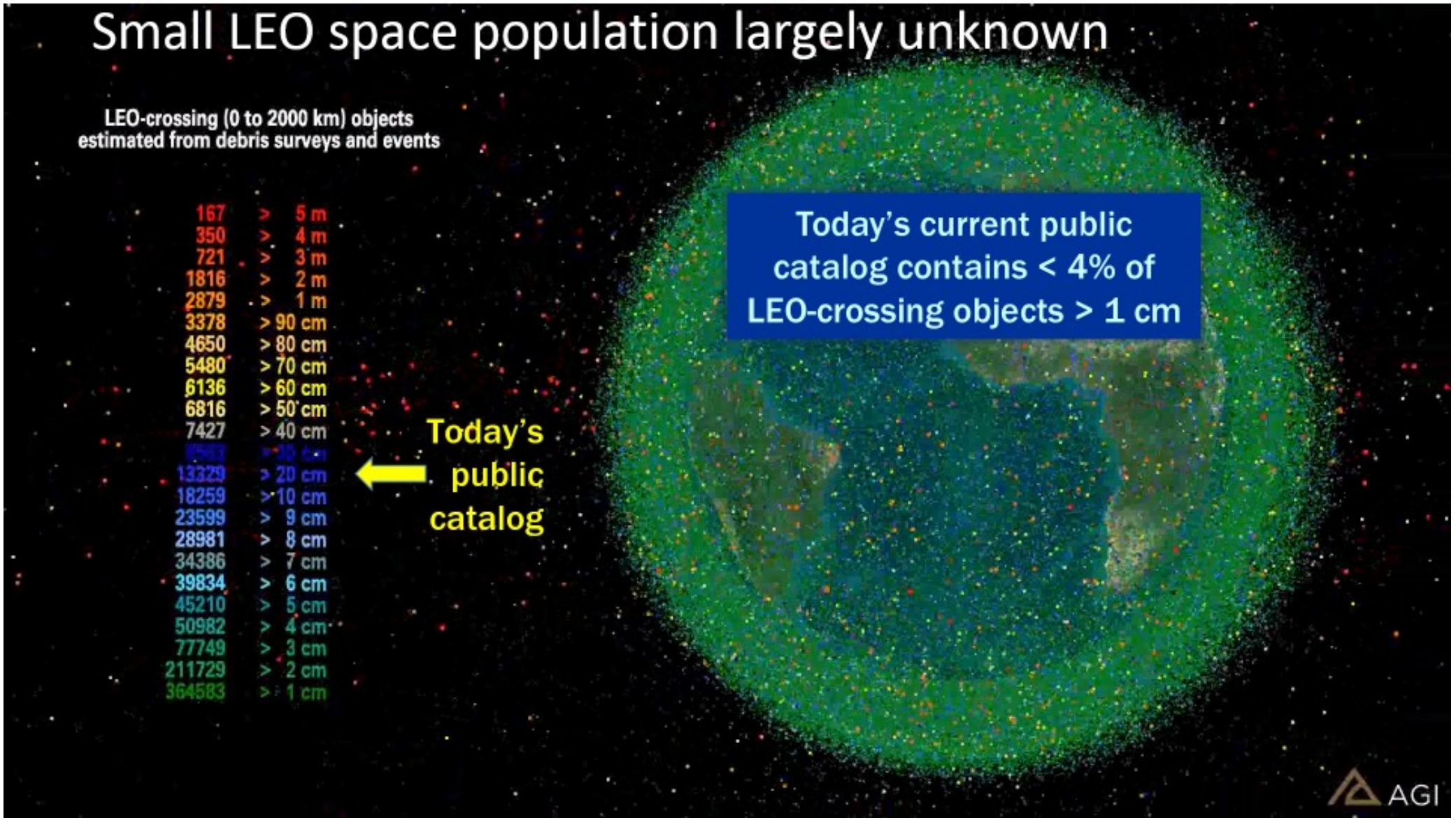
2) Anti-satellite weapo
   - Conventional
   - Nuclear
   - Direct energy – radic
     - Jamming / disruptior

3) Cyber

- Only non-kinetic cap
  military operations

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

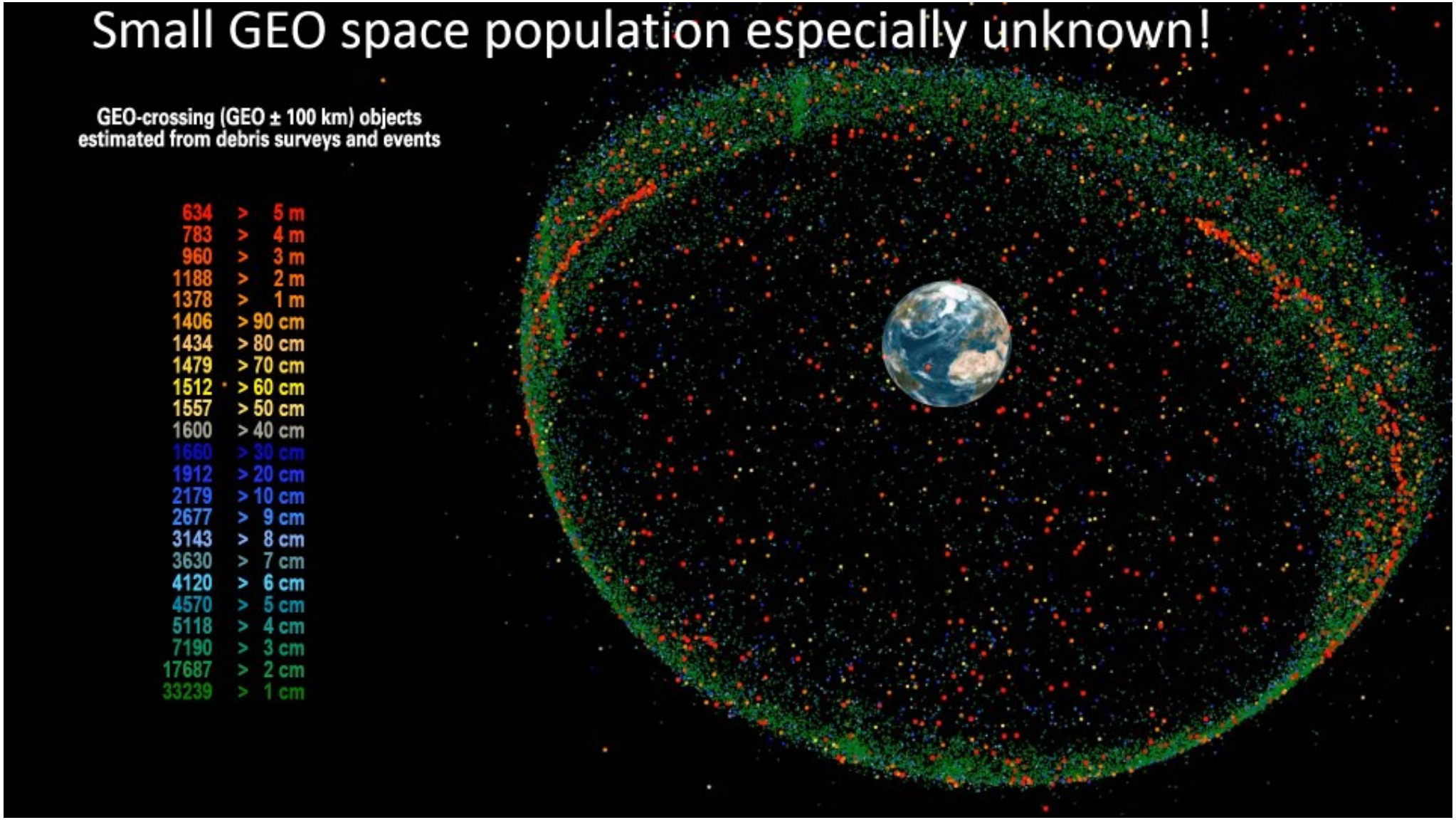



Small LEO space population largely unknown
LEO-crossing (0 to 2000 km) objects
estimated from debris surveys and events
167 > 5 m
350 > 4 m
721 > 3 m
1816 > 2 m
2879 > 1 m
3378 > 90 cm
4650 > 80 cm
5480 > 70 cm
6136 > 60 cm
6816 > 50 cm
7427 > 40 cm
13329 > 20 cm
18259 > 10 cm
23599 > 9 cm
28981 > 8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

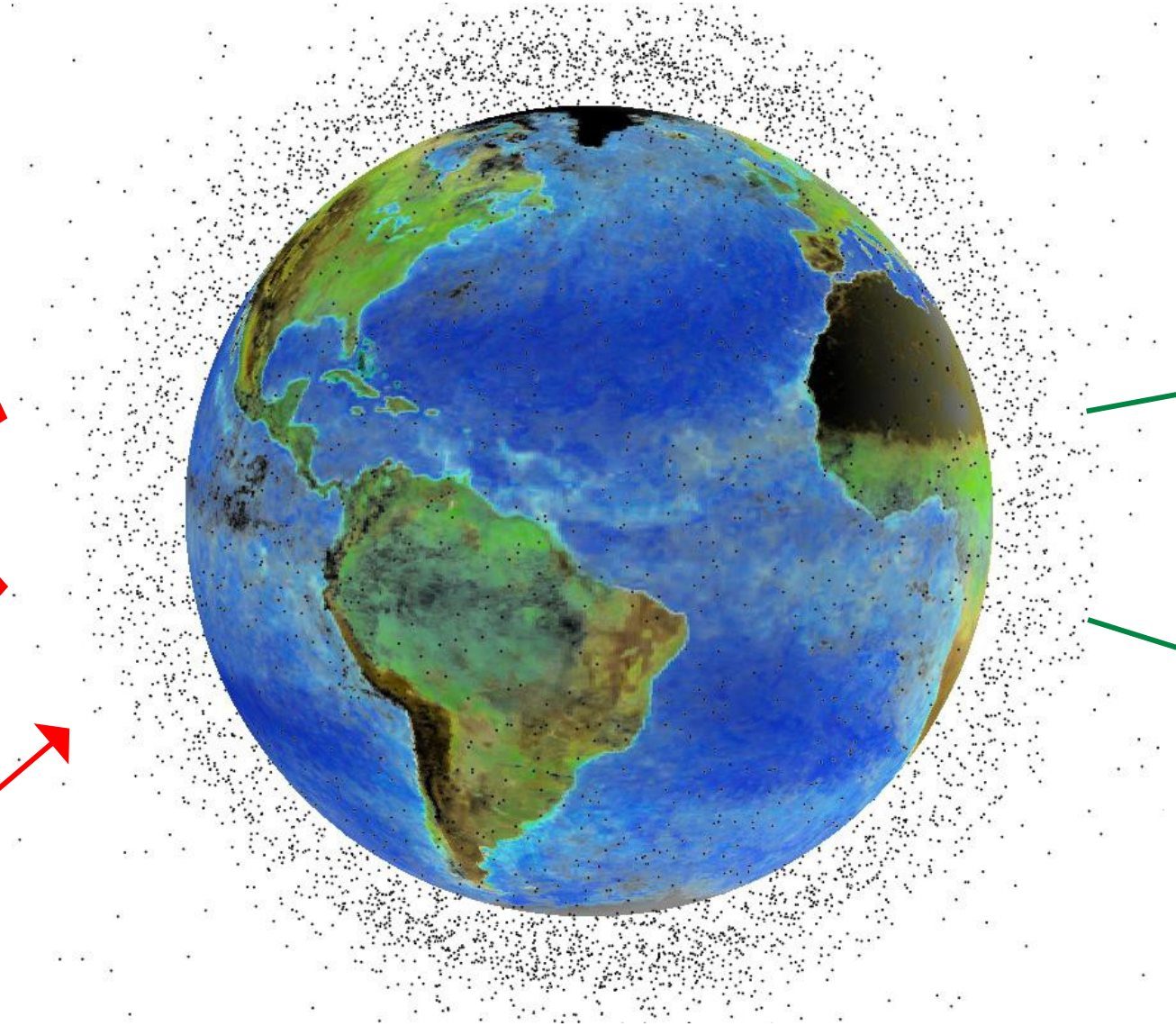


Sources

Launches (rocket bodies, payloads, mission related objects)

Fragmentations (explosions, collisions)

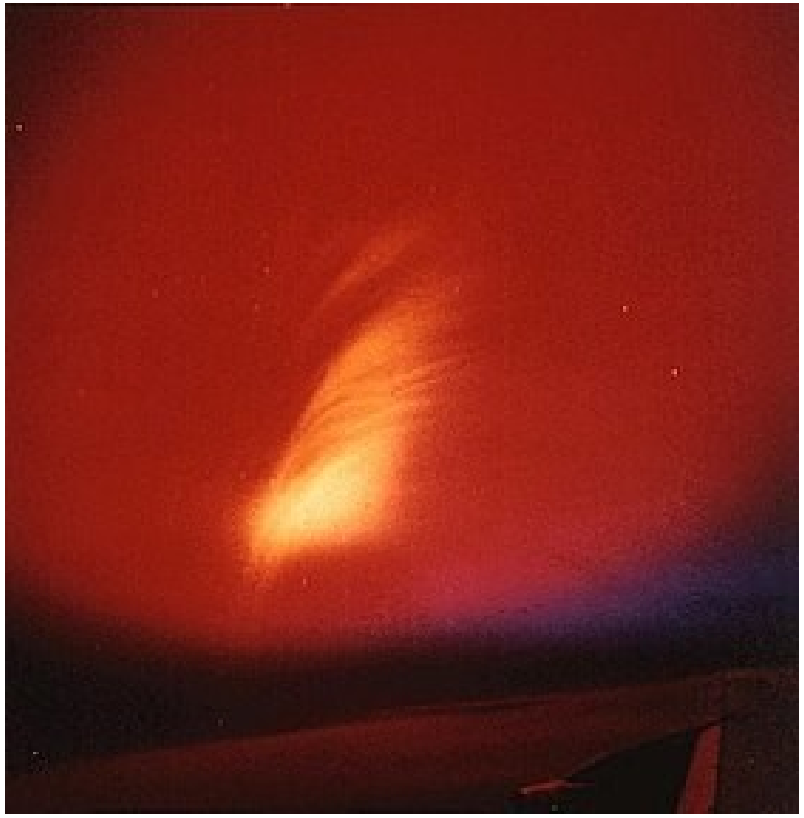
Non-fragmentation debris (surface degradation, solid rocket motor particles)



Sinks

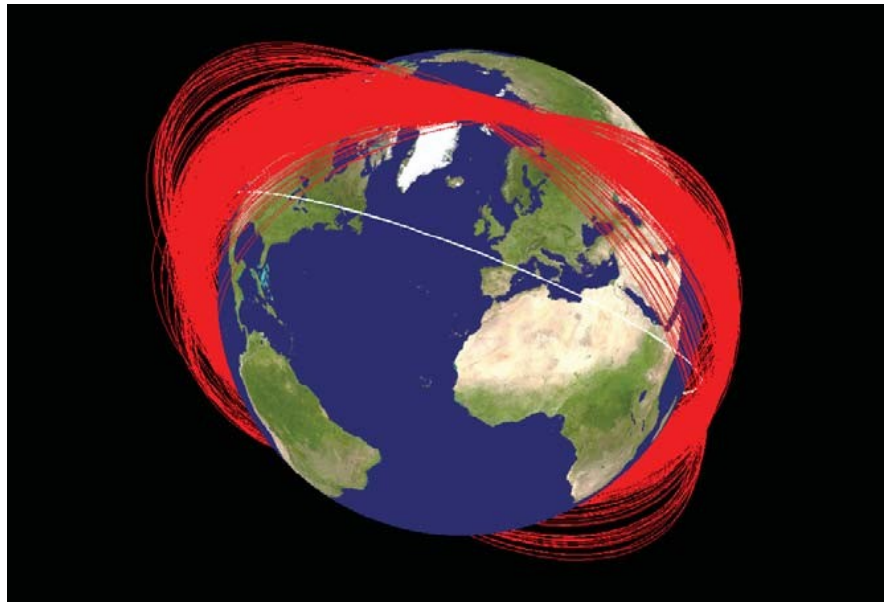
Natural decay (atmospheric drag, solar radiation pressure, lunisolar perturbations)

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



Starfish Prime
1962

SM-3 missile
2008



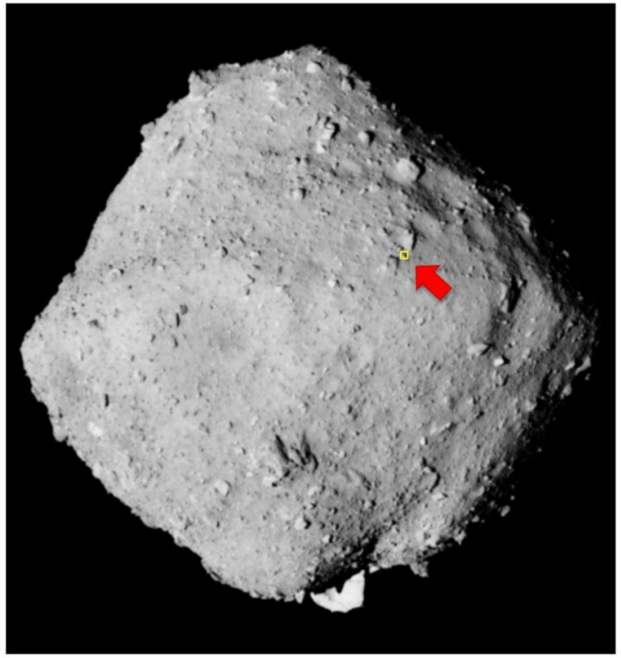
Fengyun-1C
2007

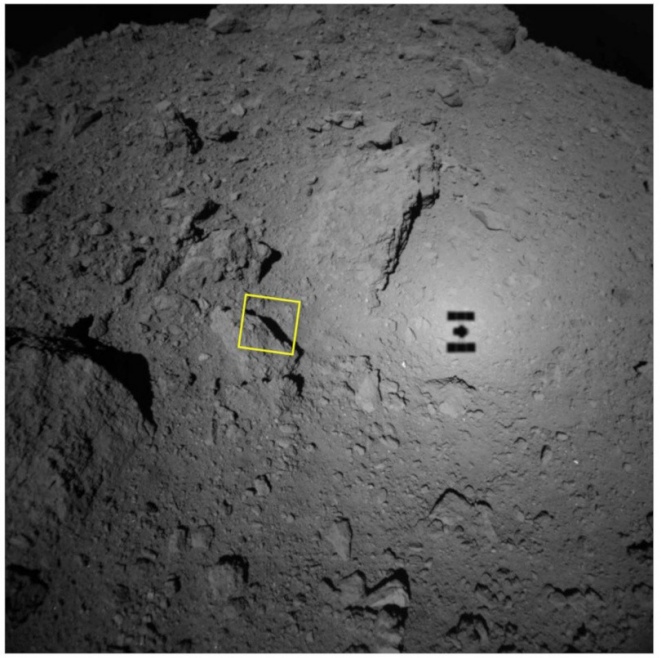
Current trends

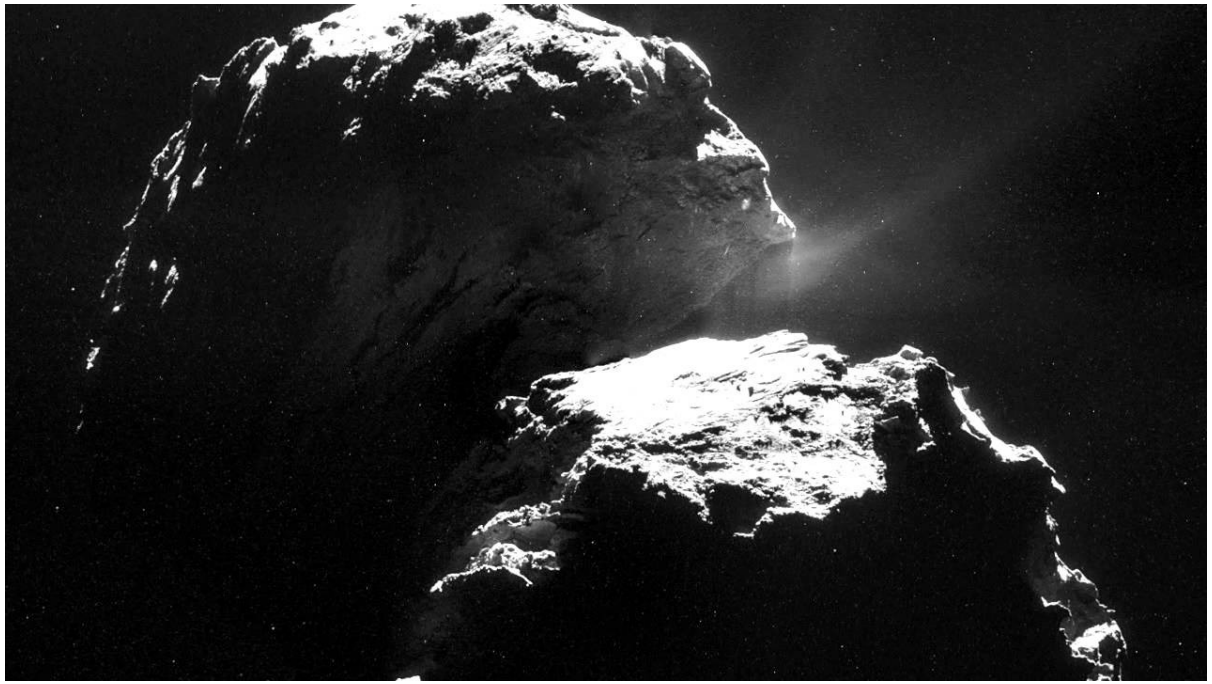
- Privatization + commercionalization
- Turism
- Asteroid mining?
- Growing number of actors

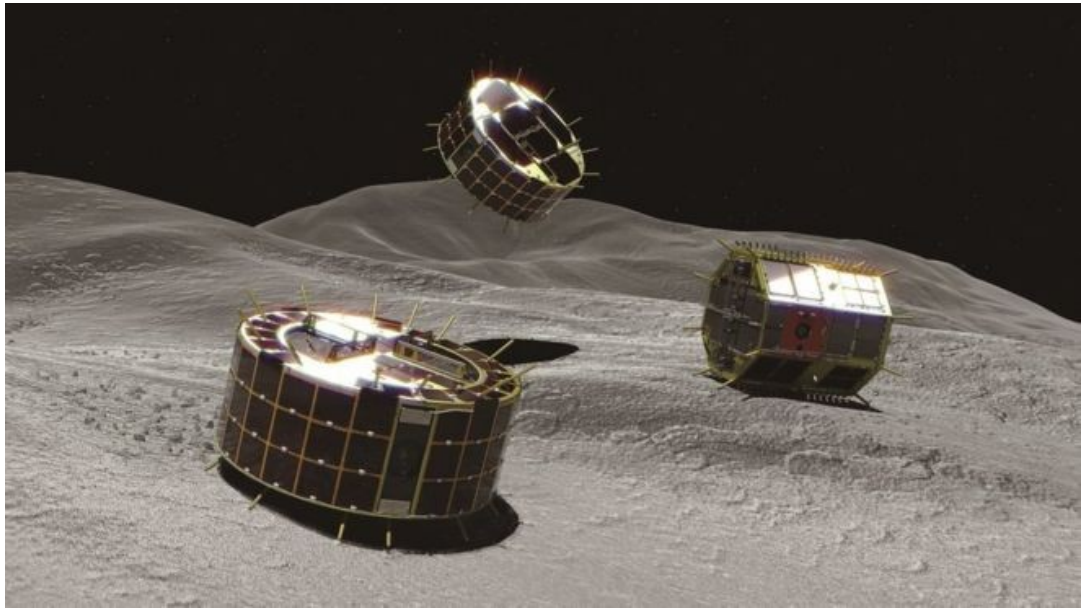
NewSpace / Space 4.0


Rosetta orbiter
Philae lander









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

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