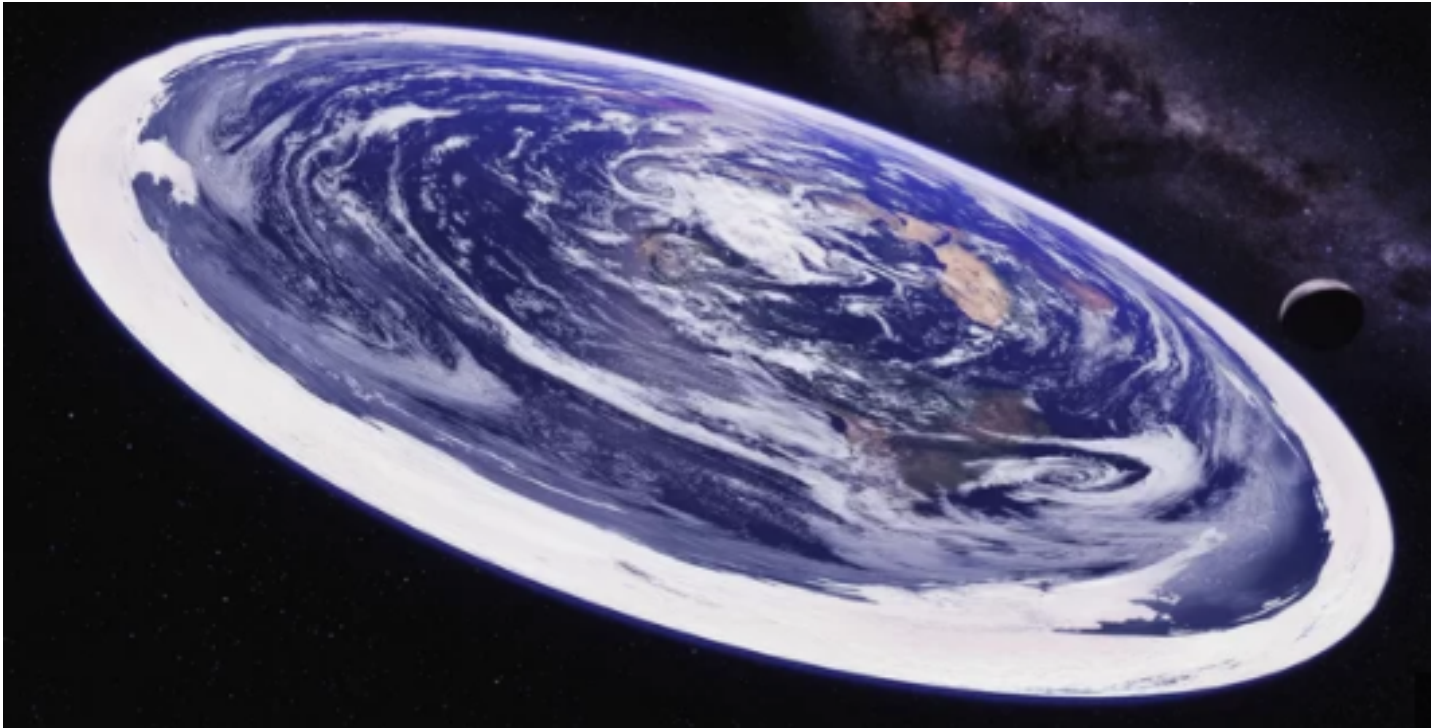


Oh what a lovely load of Garbage



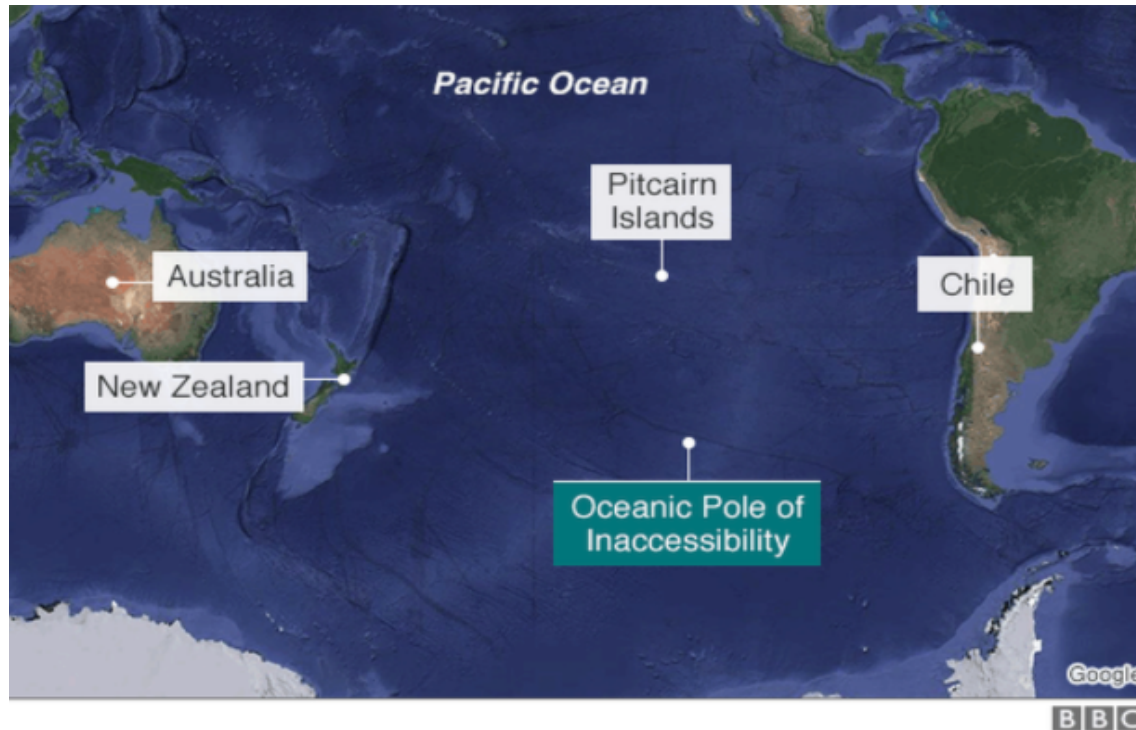
Only 66 percent of 18- to 24-year-olds in the U.S. are confident that the world is round, according to a new national survey.

Facts and figures about the shuttle

- Shuttle performance:
 - Shuttle empty = 165000 pounds, 73.7 tons.
 - External tank empty = 78100 pounds, 34.8 tons.
 - Solid rocket boosters empty each = 186000 pounds, 83 tons.
 - Each solid rocket booster holds = 1.1 million pounds of fuel, 491 tons.
 - Gross lift off weight is 4.5 million pounds, 2009 tons.
 - Velocity 17500 mph.
 - Orbit range 115 to 400 miles.
 - Total thrust at lift off is 7 million pounds (3125 tons)
 - Main engine provides (3 off) 3.7 million pounds of thrust.
 - Payload into orbit LEO(60000 pounds 26.7tons).
 - Payload to ISS (35380 pounds, 15.8 tons).
 - Payload to GTO (8400 pounds, 3.75 tons).
 - Main engine lifetime of 27000 seconds. (equivalent to 55 missions).
 - Cost of launch in 2011 is \$1.5 billion.
 - [Riding the Booster with enhanced sound.mp4](#)



Spacecraft grave-yard. Pole of inaccessibility



This oceanic pole of inaccessibility is not only of interest to explorers, satellite operators are interested in it as well. That's because most of the satellites placed in orbit around the Earth will eventually come down, but where?

Smaller satellites will burn up but pieces of the larger ones will survive to reach the Earth's surface. To avoid crashing on a populated area they are brought down near the point of oceanic inaccessibility.

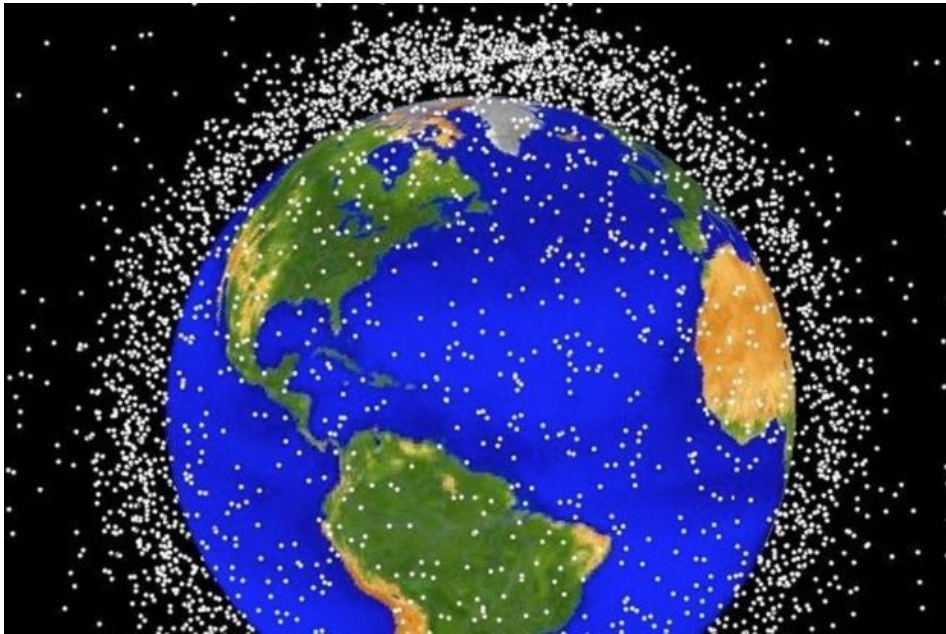
Scattered over an area of approximately 1,500 sq km (580 sq miles) on the ocean floor of this region is a graveyard of satellites. At last count there were more than 260 of them, mostly Russian.

Artists impression of the re-entry of MIR in 2001



Launched in 1986 and dumped in the ocean in 2001, with fragmenting mass of 120 tons

Space Junk in orbit around the earth.



For Geo-stationary satellites the graveyard for spent satellites is a few hundred kilometres above the geo orbit of ≈ 26000 miles

About **1,100** active satellites, both government and private. Plus there are about **2,600** ones that no longer work. Russia launched the first satellite, Sputnik 1, in 1957.

Vanguard 1 was the **first satellite** to have **solar** electric power. Although communication with the satellite was lost in 1964, it remains the oldest man-made object still in orbit, together with the upper stage of its launch vehicle



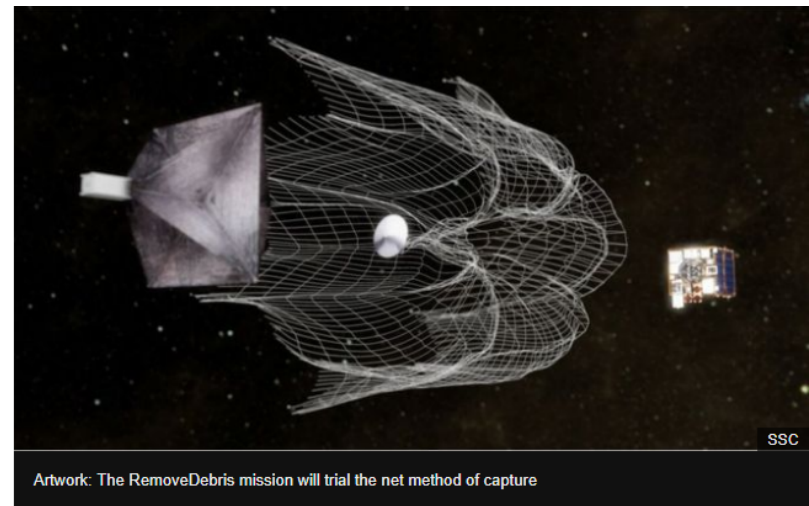
Launch of a debris clearer Trials will start in May 2018

A UK-led experiment to tackle space junk has been sent into orbit.

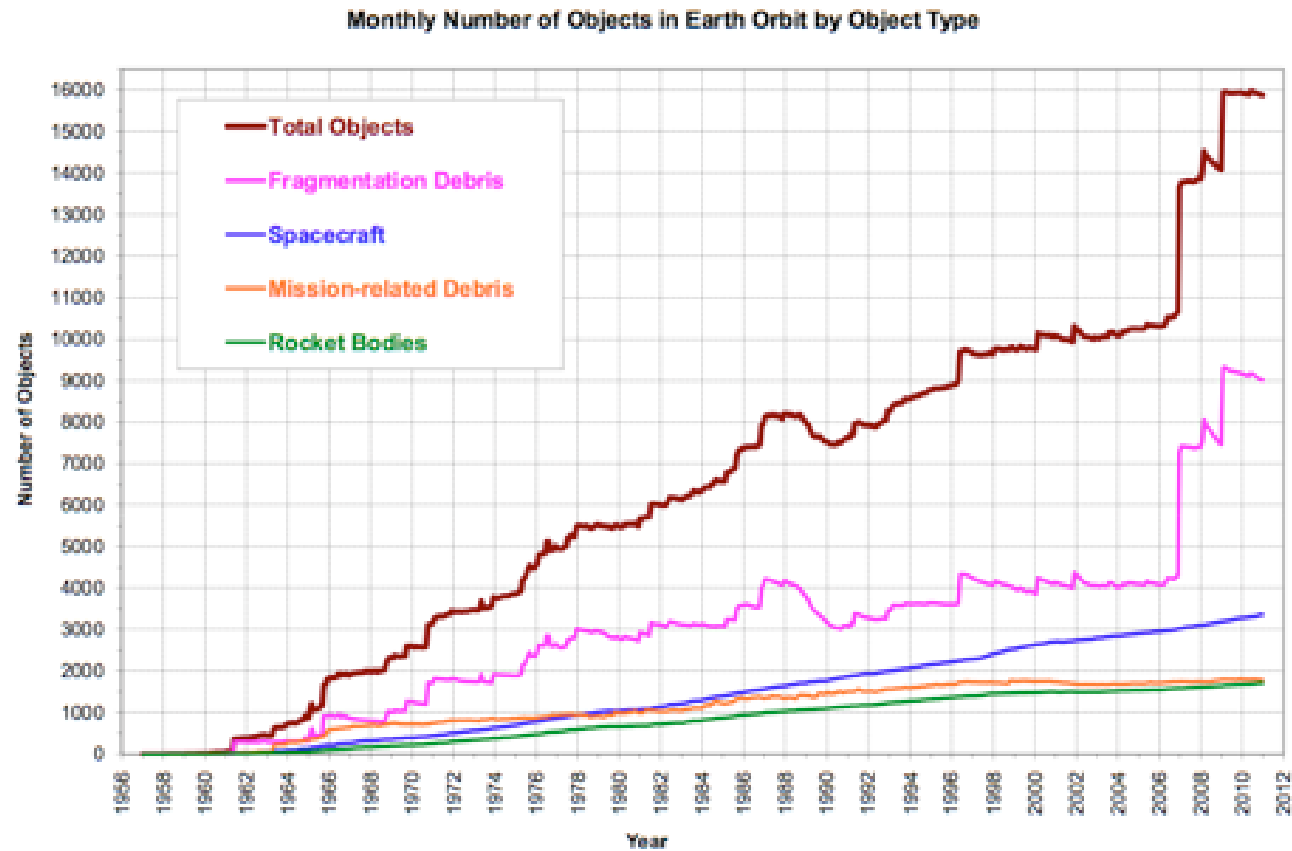
It takes the form of a small satellite that will practise techniques for tracking debris and capturing it.

The **RemoveDebris** system is heading to the International Space Station where astronauts are expected to set the experiment running in late May.

[Space debris - efforts to clean up space.mp4](#)



Objects in Orbit



How much junk is up there, satellites I mean!

According the UCS the main purposes for the operational satellites are:

Communications: 742 satellites

Earth observation: 596 satellites

Technology development/demonstration: 193 satellites

Navigation/Positioning: 108 satellites

Space science: 66 satellites

Earth science: 24 satellites

Space observation: 9 satellites

How many of these orbiting satellites are working?

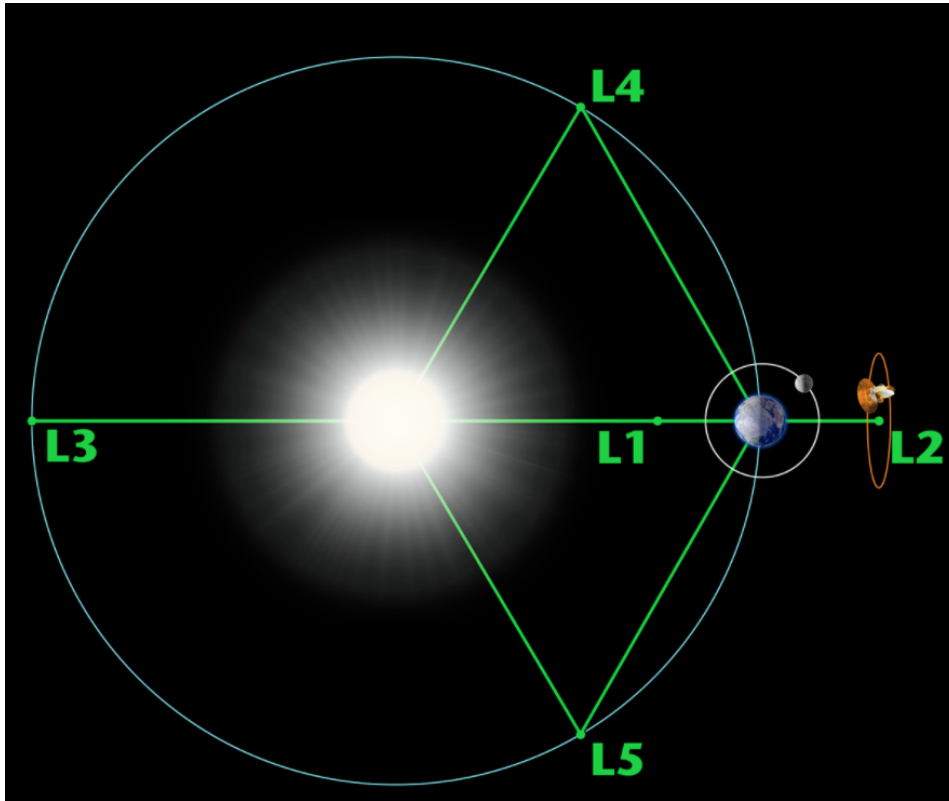
The

[Union of Concerned Scientists \(UCS\)](#)

keeps a record of the operational satellites and you may be surprised to know that only 37.5% of the orbiting satellites are active, just 1 738 according to the August 2017 update.

This means that there are 2 897 pieces of junk metal hurtling around the Earth at high speed!

The five Lagrange points



centrifugal force felt by a much smaller third body. The interaction of the forces creates a point of equilibrium where a spacecraft may be "parked" to make observations.

These points are named after Joseph-Louis Lagrange, an 18th-century mathematician who wrote about them in a 1772 paper concerning what he called the "three-body problem." They are also called Lagrangian points and liberation points.

[NASA - 'L2' Will be the James Webb Space Telescope's Home in Space](#)

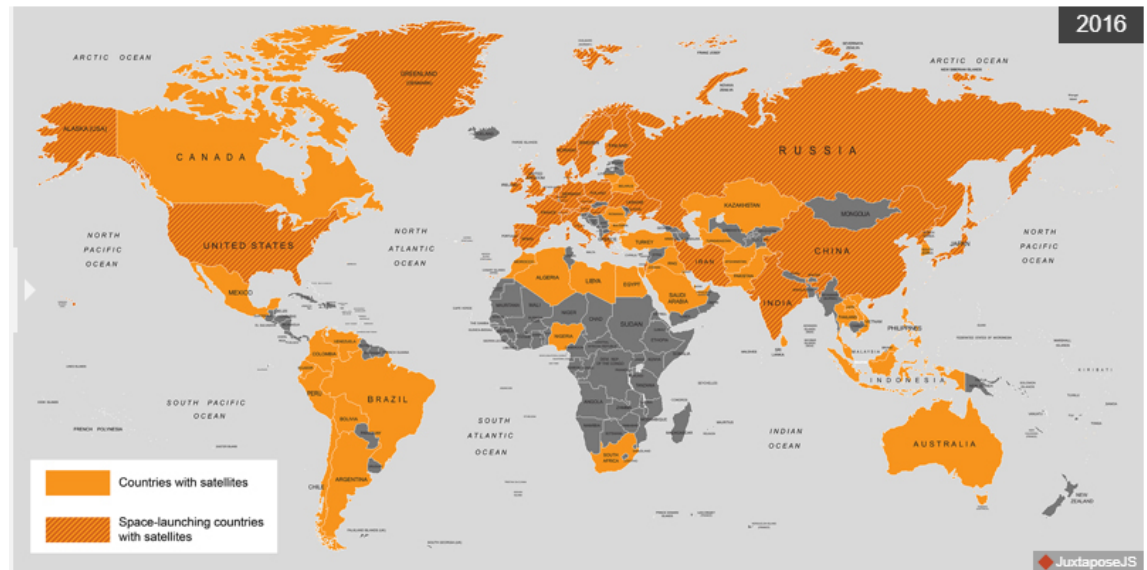
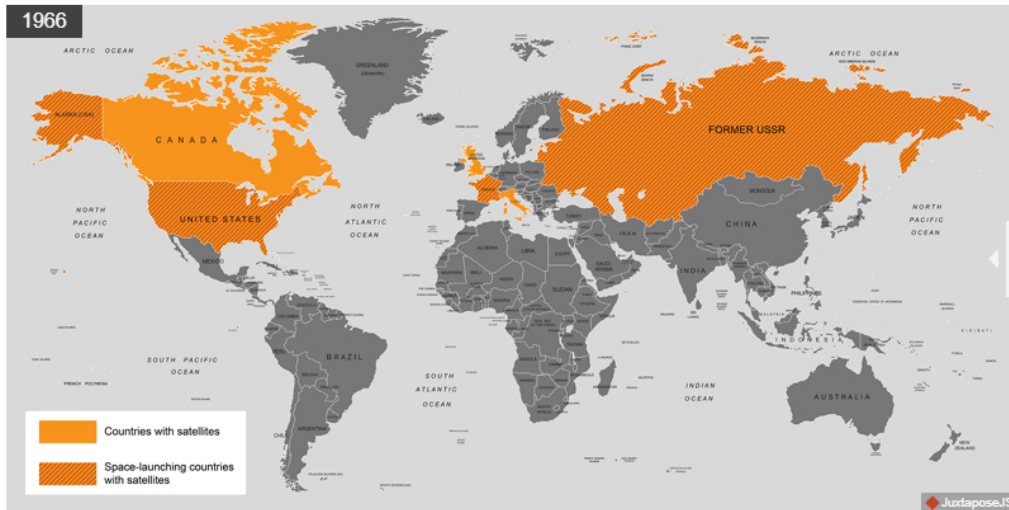
[lagrange points animation.mp4](#)

Interesting Facts!

Just a few of the interesting things we've pulled out of the UCS database:

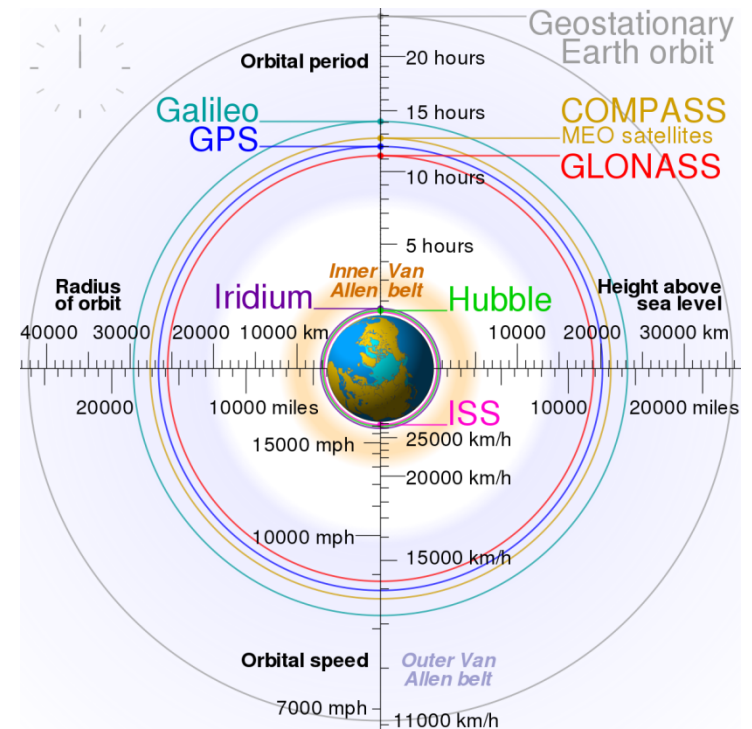
- The oldest **active satellite is the AMSAT-Oscar 7** communications satellite which was launched 43 years ago today! (15th November 1974)
- Planet operates the largest number of satellites with their constellations accounting for 191 of current active satellites – although with Planet this could have gone up already! Second largest operator is Iridium Communications with 83 satellites.
- 61.6% of operational satellites are in low-earth orbits (LEO), 30.6% in geostationary orbits, 5.6% in medium-earth orbits and 2.2% in elliptical orbits.
- Of the LEO, 55.4% are sun-synchronous, 25.6% are non-polar inclined, 15.6% are polar, 1.9% are equatorial, 0.8% are elliptical and 0.1% are cislunar (and yes, we had to look that one up too!) The remainder did not specify an orbit type
- **A UK-led experiment to tackle space junk is set to head into orbit.**
 - It takes the form of a small satellite that will practise techniques for tracking debris and capturing it.
 - The **RemoveDebris** system is going to the International Space Station where astronauts are expected to set the experiment running in late May.
 - Space junk is an ever-growing problem with more than 7,500 tonnes of redundant hardware now thought to be circling the Earth.
 - Ranging from old rocket bodies and defunct spacecraft through to screws and even flecks of paint - this material poses a collision hazard to operational missions.

Number of countries operating satellites



Some terms

- LEO – Low earth orbit – 180 miles to about 1200 miles above the surface of the earth.
- Orbital speeds are a balance between centripetal forces and centrifugal force
- Approximately 120 miles (193 Km) up is considered space
- A sounding rocket, used to study the atmosphere or perform brief experiments, is only capable of sub-orbital spaceflight and cannot reach orbit.
- A small-lift launch vehicle is capable of lifting up to 2,000 kg (4,400 lb) of payload into low Earth orbit (LEO).
- A medium-lift launch vehicle is capable of lifting 2,000 to 20,000 kg (4,400 to 44,100 lb) of payload into LEO.
- A heavy-lift launch vehicle is capable of lifting 20,000 to 50,000 kg (44,000 to 110,000 lb) of payload into LEO.
- A super-heavy lift vehicle is capable of lifting more than 50,000 kg (110,000 lb) of payload into LEO.



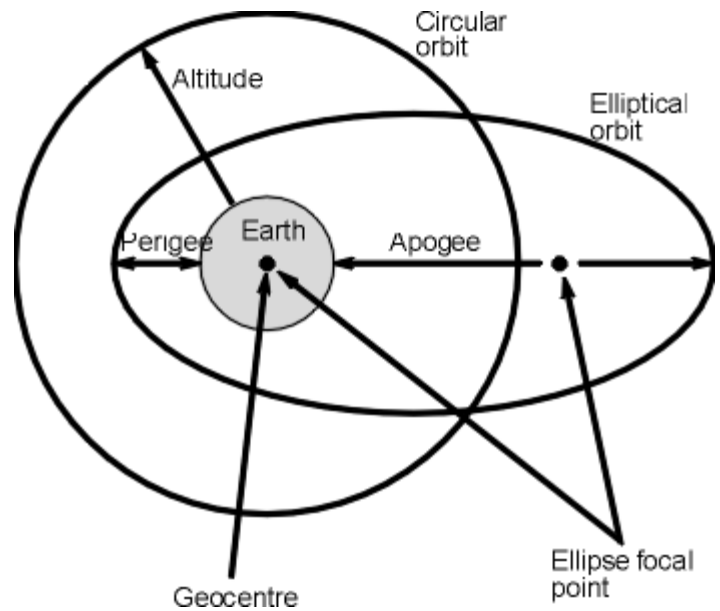
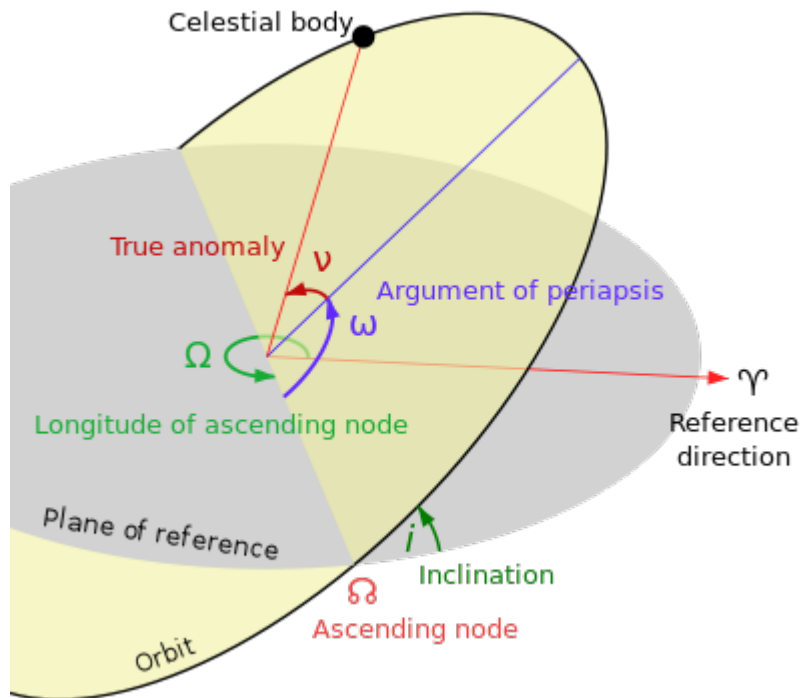
Geo stationary orbit

$$a = \sqrt[3]{\mu \left(\frac{P}{2\pi} \right)^2}$$

where a is the semi-major axis, P is the [orbital period](#), and μ is the [geocentric gravitational constant](#), equal to $398,600.4418 \text{ km}^3/\text{s}^2$.

- Orbital characteristics
- Circular Earth geosynchronous orbits have a [radius](#) of 42,164 km (26,199 mi). All Earth geosynchronous orbits, whether circular or elliptical, have the same [semi-major axis](#).^[5]
In fact, orbits with the same period always share the same semi-major axis:
- In the special case of a geostationary orbit, the [ground track](#) of a satellite is a single point on the [equator](#). In the general case of a geosynchronous orbit with a non-zero [inclination](#) or [eccentricity](#), the ground track is a more or less distorted figure-eight, returning to the same places once per sidereal day.
- Sidereal day = 23 hours 56 minutes and 4.09 seconds.

Some orbital terms



Acknowledgements:

BBC news - Science and the environment 31/3/18.

Internet searches.

Web Sites

Atomic rockets and a mission plan to go to Mars

http://www.projectrho.com/public_html/rocket/infrastructure.php

Description and explanation of the Lagrange points.

[https://books.google.co.uk/books?](https://books.google.co.uk/books?id=75b84eCulsC&pg=PA93&lpg=PA93&dq=earth+lagrange+points+spacecraft+graveyard&source=bl&ots=chPhxvPODB&sig=AvIL6aSWGhPL1IG56v1qkesuvjU&hl=en&sa=X&ved=0ahUKEwimncmakZfaAhVXF8AKHbarAE8Q6AEIYjAK#v=onepage&q=earth%20lagrange%20points%20spacecraft%20graveyard&f=false)

[id=75b84eCulsC&pg=PA93&lpg=PA93&dq=earth+lagrange+points+spacecraft+graveyard&source=bl&ots=chPhxvPODB&sig=AvIL6aSWGhPL1IG56v1qkesuvjU&hl=en&sa=X&ved=0ahUKEwimncmakZfaAhVXF8AKHbarAE8Q6AEIYjAK#v=onepage&q=earth%20lagrange%20points%20spacecraft%20graveyard&f=false](https://books.google.co.uk/books?id=75b84eCulsC&pg=PA93&lpg=PA93&dq=earth+lagrange+points+spacecraft+graveyard&source=bl&ots=chPhxvPODB&sig=AvIL6aSWGhPL1IG56v1qkesuvjU&hl=en&sa=X&ved=0ahUKEwimncmakZfaAhVXF8AKHbarAE8Q6AEIYjAK#v=onepage&q=earth%20lagrange%20points%20spacecraft%20graveyard&f=false)

<https://www.pixalytics.com/sats-orbiting-earth-2017/>

Thanks for staying awake and for the lucky ones that are still lucid. The next slide is a video of the view from L1 entitled “Nuclear Art” released by NASA from the “Solar Dynamics Observatory (SDO)”. [9.3 million miles from earth or about 83 million miles from the SUN and the Sun's diameter is 864,575.9 miles and subtends an angle of 0.53 deg.

Nuclear Art

- This is video created from the satellite (SDO) orbiting LaGrange point L1.
- The Solar Dynamics Observatory is a NASA mission which has been observing the Sun since 2010. Launched on February 11, 2010, the observatory is part of the Living With a Star program
[NASA - Thermonuclear Art – The Sun In Ultra-HD \(4K\).mp4](#)
- Any Questions

