

Space junk

Science background: Space Junker

What's the issue?

Who should pay to clear up space junk?

Thousands of pieces of debris are orbiting the Earth, travelling at over 27,000 km/h.¹

This space junk can collide with and destroy essential satellites, knocking out communications – and in turn creating even more junk. As the layer of junk gets thicker, it's becoming more dangerous to launch satellites and send astronauts into space.

Our lifestyle depends on satellites in orbit, but space junk poses a real danger. Clearing the junk is going to be essential if we don't want to be cut off from space. Who's to blame for all that junk, and who should pay for keeping our skies clear?

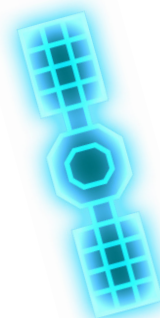
Key terms

Space junk includes old dead satellites, fuel tanks, everyday rubbish from past space stations, lost tools from spacewalks, and even astronauts' gloves, along with natural debris from space. Junk can range in size from dust to very tiny fragments (called 'bullets') to full-size satellites ('cars').

Low Earth orbit is 500 km above the Earth's surface. This is where most of the junk is, and is also the region where we have had most manned spacecraft and many scientific satellites.

Middle Earth orbit is about 2000 km above the Earth's surface. This is where you find the GPS system of satellites, orbiting twice a day.

Geostationary orbit is 36,000 km above Earth. Satellites here stay above a fixed point on the Earth and are usually for communications, television signals and monitoring the weather. They orbit once a day.



Clear the space junk that threatens the satellites we depend on.

What's all the fuss about?

Space junk orbits in the same region of space as the satellites we use for communication, Earth observation and space exploration.

If junk collides with a working satellite it can destroy the satellite, and create even more fragments of dangerous junk which could crash into other satellites.

If we fail to control our space junk problem, we could find ourselves losing important communications systems, and unable to launch new satellites or safely bring back astronauts from missions.

Scientists are working on ways to remove the junk, but these solutions will be extremely expensive. Should every satellite that's sent up have a decommissioning plan to remove it at the end of its life?

Should clearing space junk be the responsibility of those launching the satellites (e.g. mobile phone companies)? Or is it up to the people who benefit from the satellites, in other words, you?

Key facts

- The Space Surveillance Network (SSN) has been tracking and cataloguing space objects since 1957, when the Soviets opened the Space Race by launching their satellite Sputnik I. As of 2010 the SSN has monitored over 8000 human-made objects. Only about 600 of these are working satellites.²
- The International Space Station and the Hubble Space Telescope are both in low Earth orbit, the same orbit as most of our space junk.²
- The UK had 28 satellites in orbit in 2012, which doesn't sound like much when compared to Russia (1446 satellites) and the United States (1111).³
- A commercial satellite launch costs about \$50 million. Satellites themselves are pretty pricey too, averaging about \$99 million each.⁴



Scientists from all over the world work together on the International Space Station, the biggest satellite in low Earth orbit. A piece of orbiting junk came dangerously close to colliding with it in June 2011.

Do collisions really happen?

Even though space is so large, collisions happen. In 2009 a working Iridium 33 telecommunications satellite and a dead Kosmos 2251 satellite collided 800 km above the Earth at 43,000 km/h, destroying both. Satellites and space junk travel in all directions in their orbits, so collisions can occur head on at very high speeds. And collisions are probably happening more often than we realise, when junk hits junk and causes a cascade of tiny new bullets in orbit.

What plans are there for clearing space junk?

Most plans to control the risk of space junk involve removing satellites after they've reached the end of their useful life, or making sure that objects such as rocket boosters are made safe by removing their fuel to reduce the chance of an explosion. Plans to remove pre-existing junk include space nets to capture it and tow it down into the atmosphere or using powerful lasers to push space junk around in orbit.

Does junk stay up there for ever?

Not all of it. Below 400 km from the Earth's surface, space is less polluted because the space junk is slowed by the Earth's atmosphere and drops down. Although most falling space junk burns up entirely on its way through the atmosphere, some may hit the Earth's surface. Pieces of the Upper Atmosphere Research Satellite reached the Earth's surface in 2011.

Old geostationary satellites are not brought back to re-enter the atmosphere. Instead they need to have enough fuel at the end of their useful life to move them to a 'graveyard' orbit where any collision cannot harm operating satellites.

Why does some space junk fall down and some doesn't?

A satellite can slow down because air resistance in the lowest part of low Earth orbit slows it down. A piece of space junk will drop to Earth if it's going too slowly for its orbit, and gravity pulls it down. Other space junk that is higher up isn't affected by the air resistance and will keep orbiting for a very long time.

Isn't there a lot of space up there?

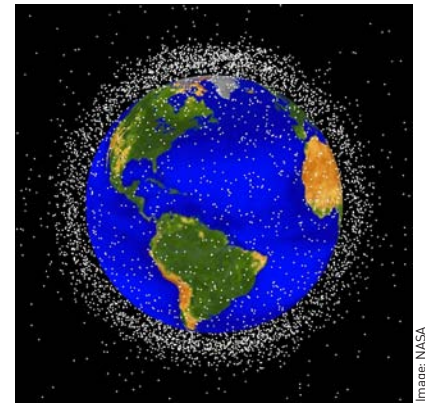
There is a lot of space and it isn't hard to launch a satellite between the space junk and the working satellites, but it is difficult to monitor all the space junk that could cross the satellite's path in the future.

So why not just get rid of it all?

Money, money, money! The proposals so far to remove pre-existing space junk are very expensive. The expense needs to be weighed against the cost of having a working satellite destroyed.

You could discuss...

- Would you pay extra on your mobile phone bill to help clean up space?
- What satellites would you try to protect?
- Is cleaning our orbit space worth the time and money?
- Do you think space junk is even a problem?
- If companies are made responsible for clearing commercial space junk, who should have to clear junk created during scientific research?
- Imagine the world if all satellites were down at once. What would it be like?



The distribution of space junk in low Earth orbit. A collision between two satellites in 2009 caused a huge cascade of junk as thousands of tiny fragments shot off in every direction.

Links to the Science Museum

In the *Exploring Space* gallery you will find Black Arrow, developed by Britain as its national satellite launcher.

www.sciencemuseum.org.uk/images/I052/10320807.aspx

Here you can also check out a model of Sputnik, the world's first human-made satellite.

www.sciencemuseum.org.uk/images/I051/10319126.aspx

In the *Atmosphere* gallery you can find out how satellites are used to monitor our warming world.

www.sciencemuseum.org.uk/ClimateChanging/ClimateScienceInfoZone/Exploringwhatmighthappen/2point1/2point1point2.aspx

The *Cosmos & Culture* gallery tells the story of how astronomy shaped our world. Look out for the space telescope.

www.sciencemuseum.org.uk/visitmuseum/galleries/cosmos_and_culture.aspx

Further information

BBC News item about a recent report by the US National Research Council on the dangers of space junk:

www.bbc.co.uk/news/science-environment-14763668

ESA has created a great article discussing the problems with space junk. Read more about the sources of space junk and possibilities for the future:

www.esa.int/esaMI/ESOC/SEMUZ26LARE_0.html

NASA's equivalent pages also include information on tracking the larger debris and moving satellites out of the way to avoid collisions:

www.nasa.gov/mission_pages/station/news/orbital_debris.html

Sources

- 1 NASA International Space Station feature on space debris, www.nasa.gov/mission_pages/station/news/orbital_debris.html
- 2 'Space surveillance', United States Space Command, www.au.af.mil/au/awc/awcgate/usspc-fs/space.htm
- 3 'SATCAT [satellite catalogue] boxscore', CelesTrak [data from January 2012], www.celestrak.com/satcat/boxscore.asp
- 4 Rachel Villain, 'Satellites to be built & launched by 2019', Euroconsult World Market Survey (2009)



Contemporary science discussion for the classroom
sciencemuseum.org.uk/educators

