Satellite navigation system and satellite communication

Polish Space Agency

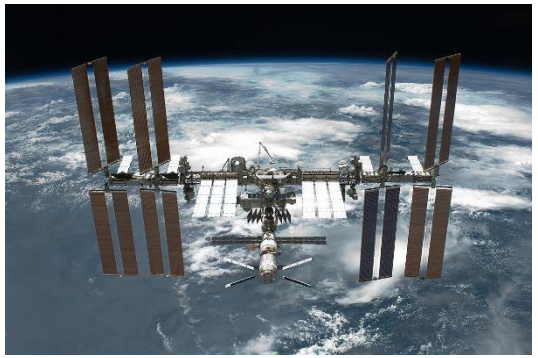
With the support of the Erasmus+ Programme of the European Union

Project 2019-1-PL01-KA201-065434

Satellite types – revision

Scientific satellites,
e.g. Hipparcos

Navigational satellites,
e.g. Galileo system



Space station, e.g. ISS

Test satellites, e.g. KIKU-7

Environmental satellites,
e.g. GOES-17

Communications satellites, e.g.
Eutelsat

Reconnaissance satellites,
e.g. Ofek-16

Source: Roberto Ziche

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In orbit

What did you see on the animation?

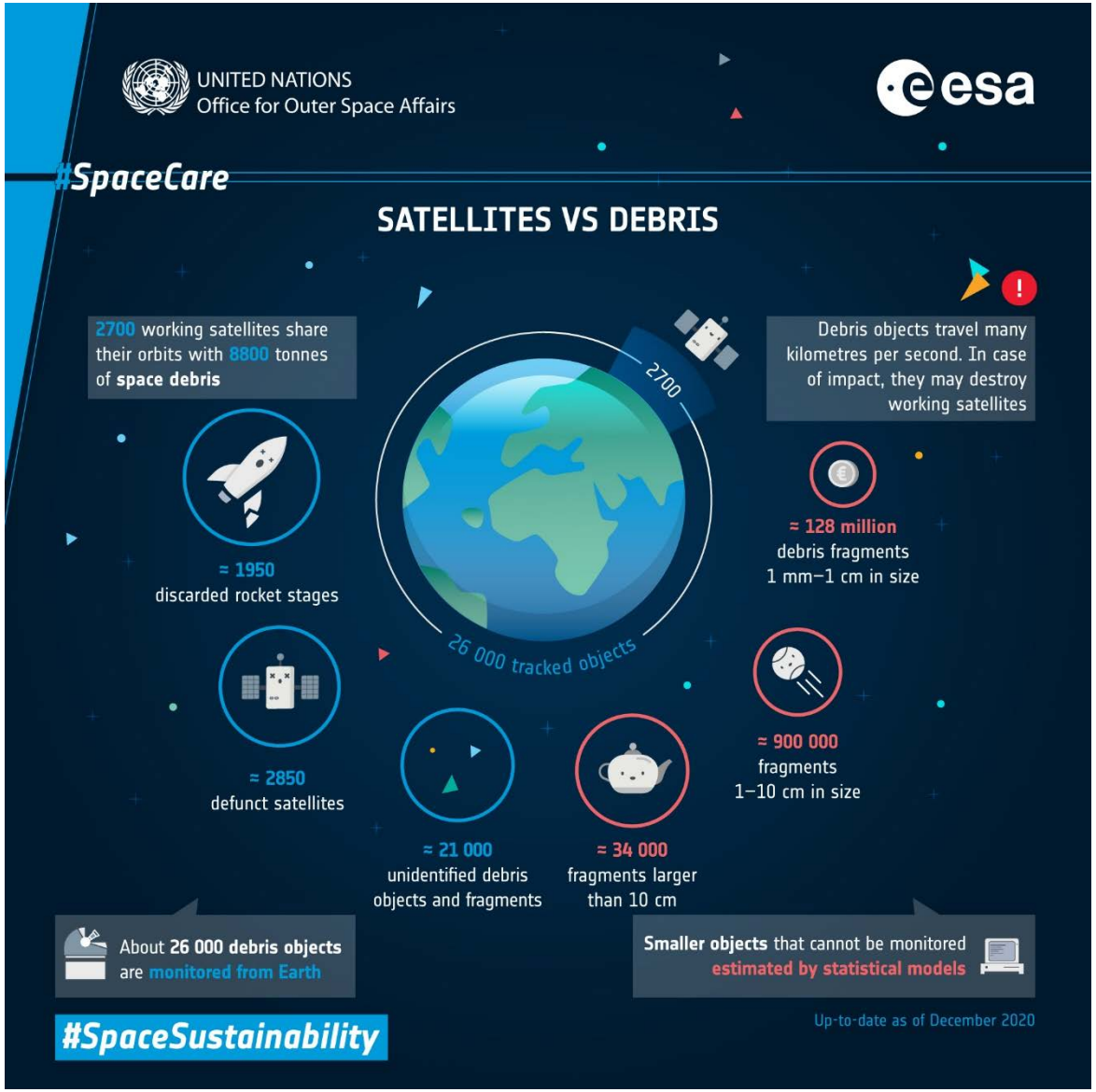
In orbit

- We were moving closer to the Earth from the level of the geostationary orbit.
- Communications and environmental satellites are often placed in a geostationary orbit.
- Positioning and navigational satellites are placed in a medium Earth orbit.
- Earth observation satellites, as well as the International Space Station and Tiangong space station, are placed in a low Earth orbit.
- The animation also shows the so-called space debris: inactive satellites, remaining parts of spacecrafts used to lift objects into space, or debris from satellite collisions.

Did you know?

Beyond the geostationary orbit, there is also another orbit called the high Earth orbit or the graveyard orbit.

In orbit

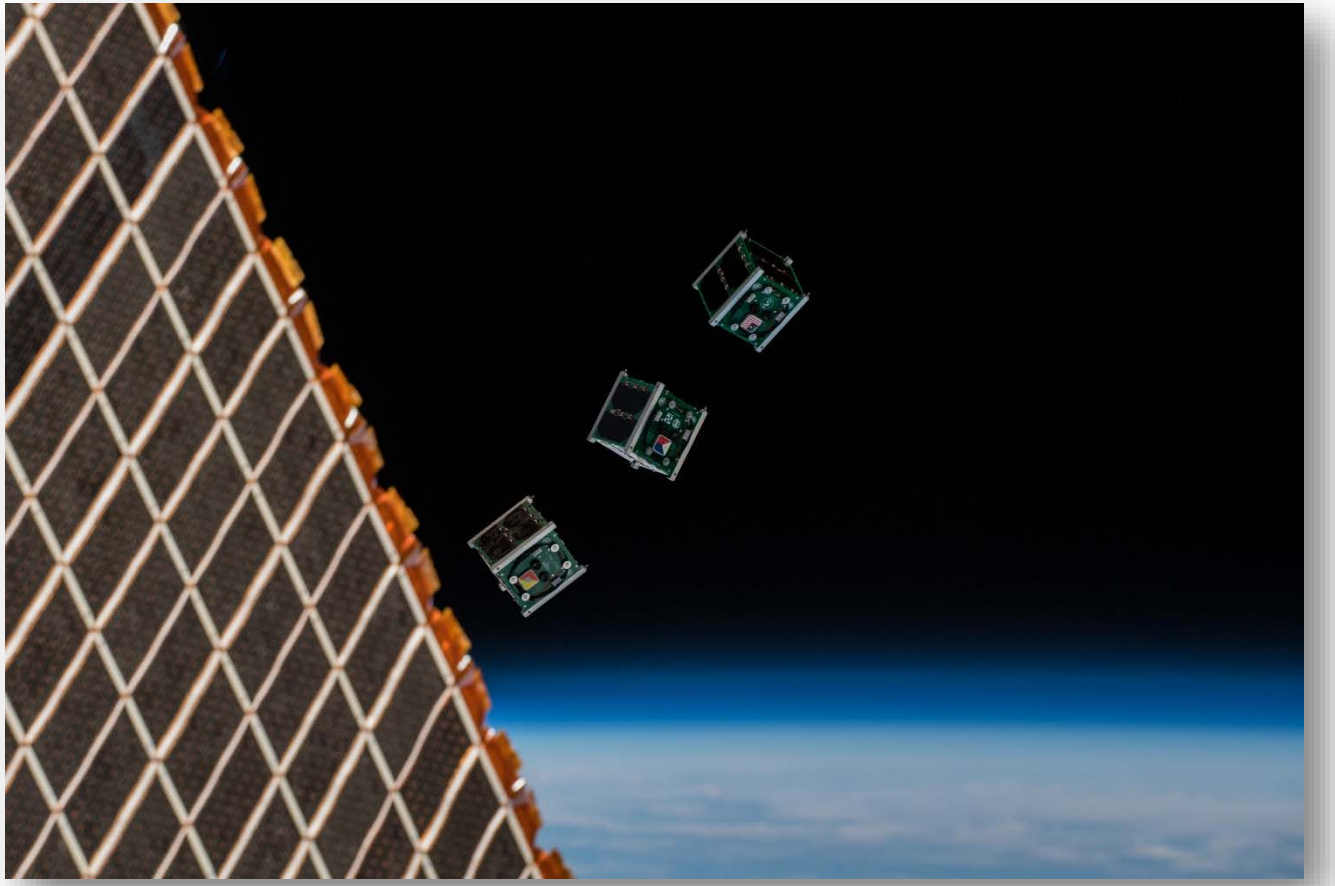


Credit: ESA / UNOOSA/Satellites vs debris

The infographic shows how many objects in orbit are still in use (operational) and how many constitute space debris; it also includes the size of the objects.

Why does it happen?

- There is an increasing demand for satellite technologies.
- The information gathered by satellites are becoming more useful and precise.
- The market is open for everyone – it is not monopolised by corporations and public bodies.
- The satellites can be small and operate individually (as educational projects or demonstrations) or operate in constellations (e.g., satellite constellations designed for Earth observation)



CubeSats launched into orbit from the ISS.

Credit: ESA/NASA-A. Gerst

Communications satellites

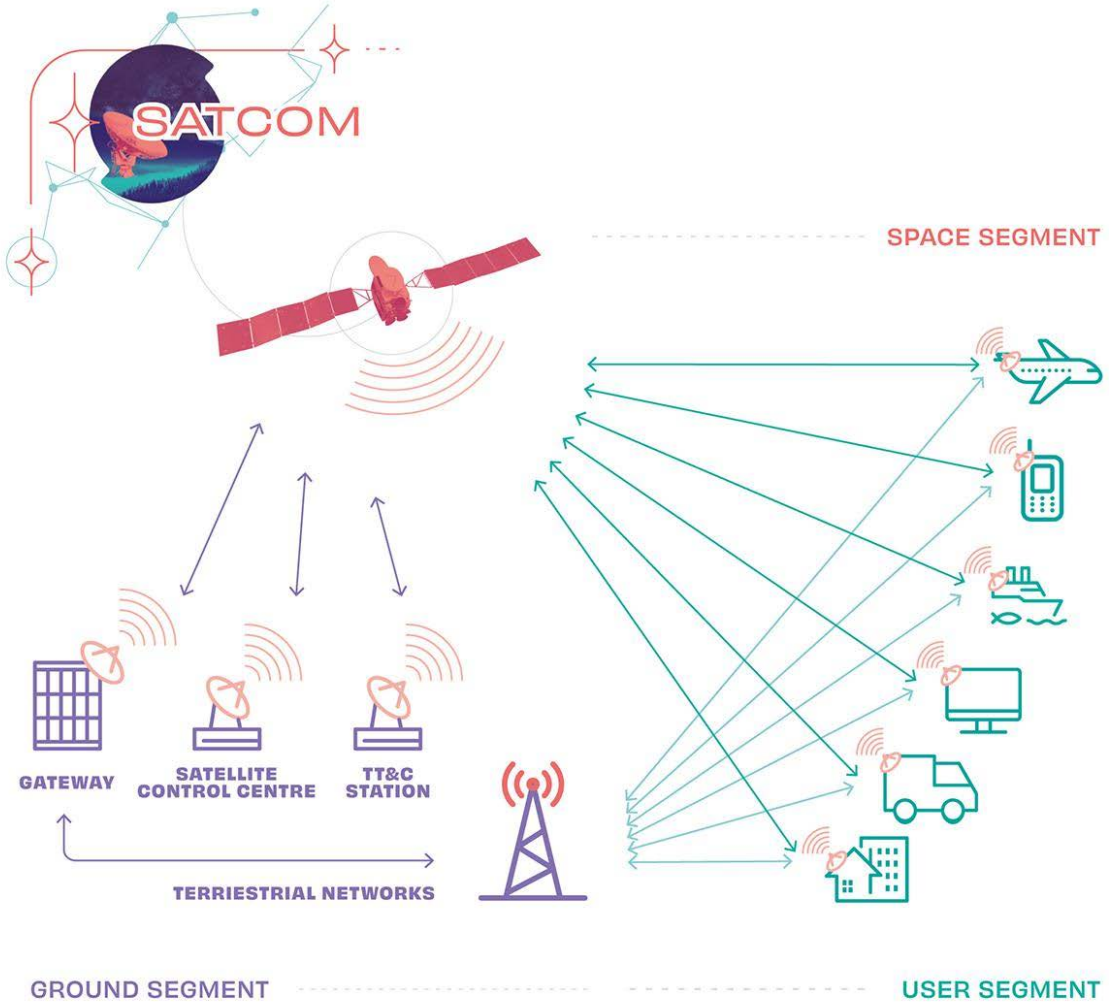
What do you think they are used for?

Communications satellites - security

There are three levels of information security when it comes to the satellite communication:

- ComSatCom - short for Commercial Satellite Communications; it is the least secured and most widely used type of satellite communications, e.g., satellite TV.
- GovSatCom - short for Government Satellite Communications; a more secured communication system used by the governments or military. GovSatCom signal cannot be received without special equipment.
- MilSatCom - short for Military Satellite Communications; a satellite communication with the highest security level, utilised for, e.g., military missions.

Satellite communications - applications



Satellite communication is used in places where the terrestrial network is not available. For example:

- In the forests;
- In the mountains;
- In the open seas and oceans;
- On the helicopters and planes.

Want to learn more?

- Visit www.eurisy.org and look up "success stories” of Satcom. Which example of the application of satellite communication do you like the most? Which one, in your opinion, would work best in your country? Why?

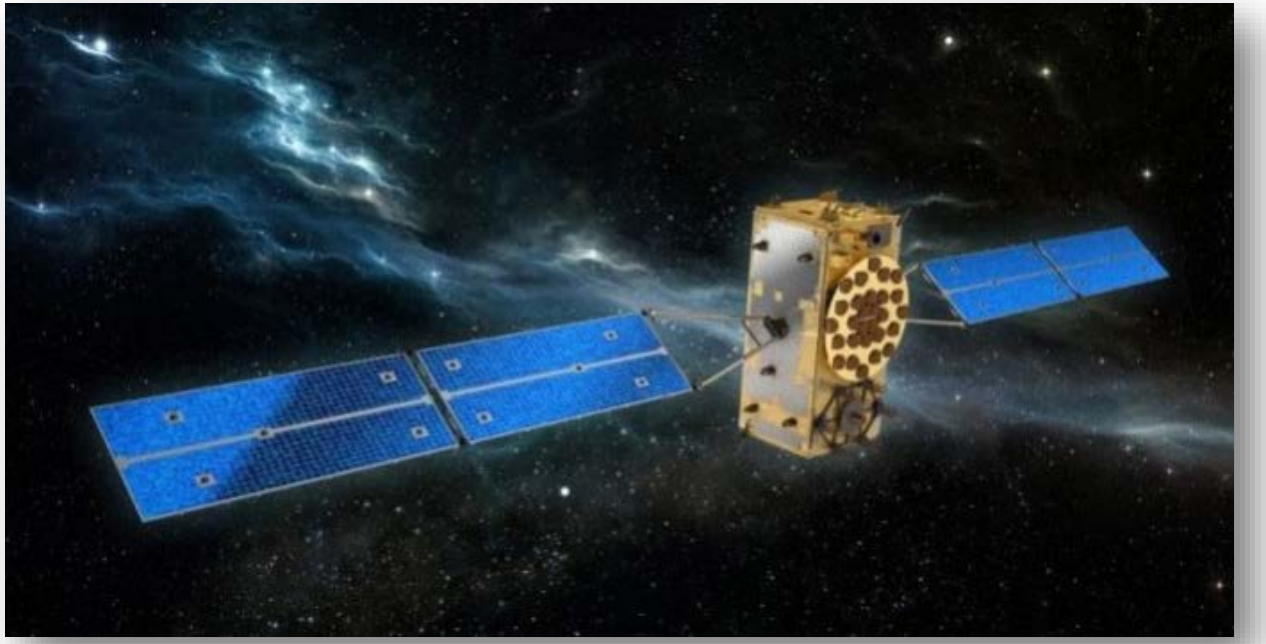
Exercise

- Divide students into 6 groups. The aim of each group is to provide communication services in a specific situation. Students have to plan out the space, control, and user segments, and specify the context, e.g., the group working on the plane communication decides that business clients will use the communication for checking mails.
- Groups: Open sea communication, emergencies, telemedicine, television, military operations, tourism.

Satellite Navigation System

How does it work?

- In the past, people were using lighthouses to find their way on the sea. Later, they started to construct radio towers. Currently, we can determine the location of an object (a car, a phone, or a plane) thanks to satellite navigation.
- The minimum number of satellites needed to determine an object's position is 4 – the more information is available, the more precisely the position will be determined.
- Satellites determine the position of an object. The terminal equipment (see: the user segment), coupled with an appropriate receiver and application (e.g. a map) where you can enter the destination point, allows effective and easy navigation.



Visualisation of the Galileo satellite

Credit: OHB

Types of satellite navigation systems:

- The most popular satellite navigation system is the **GPS (Global Positioning System)**. This system was developed for the US military and later introduced to civil users. It consists of over 30 satellites, with the first one launched in the late 70s.
- **Galileo** is a European satellite navigation system.
- **GLONASS** is a Russian satellite navigation system.
- **BeiDou** is a Chinese satellite navigation system.

All the above systems work following the same pattern, but they may differ in, e.g., the level of precision. Countries (or entities, i.e., European Commission) decide to develop their systems mainly to be independent. Our phones, however, usually can receive signals from multiple systems.

Satellite navigation system – application

- **Transport system** – road, air, rail, and even maritime transport depend on the satellite navigation system. Even drones cannot operate without a built-in navigation system. Additionally, thanks to satellite navigation, we can monitor and plan the hard infrastructure, e.g. railway systems or roads.
- **Agriculture** – the satellite navigation system, coupled with data gathered from Earth observation, allows better planning regarding the fertilization process and helps with assessing the condition and quality of crops.
- **Adapting to climate change** – when coupled with the Earth observation data, the satellite communication system allows for better planning (e.g. city infrastructure) and creates better climate change models.
- **Finance and banking** – SNS enables synchronisation of clocks in banks and markets and warrants precise data on the time of transactions.
- **Other uses:** determining the level of congestion on borders to direct drivers to other border posts (an application developed during the COVID-19 pandemic); an application allowing the civilians to report illegal landfill sites; monitoring the frequency of visits in, e.g., restaurants; emergency management.
- **And finally, how do you use the navigation system?**

Sources

- Alicja Musiał's blog: https://alicja.space/blog/satellite-orbits-overview - entry about orbits
- Satellite navigation explained, ESA website: https://www.esa.int/Applications/Navigation/How_satellite_navigation_works
- More information regarding the utilization of satellite mapping and navigation is available in the EUSPA report on the space programme – EUSPA Market Report