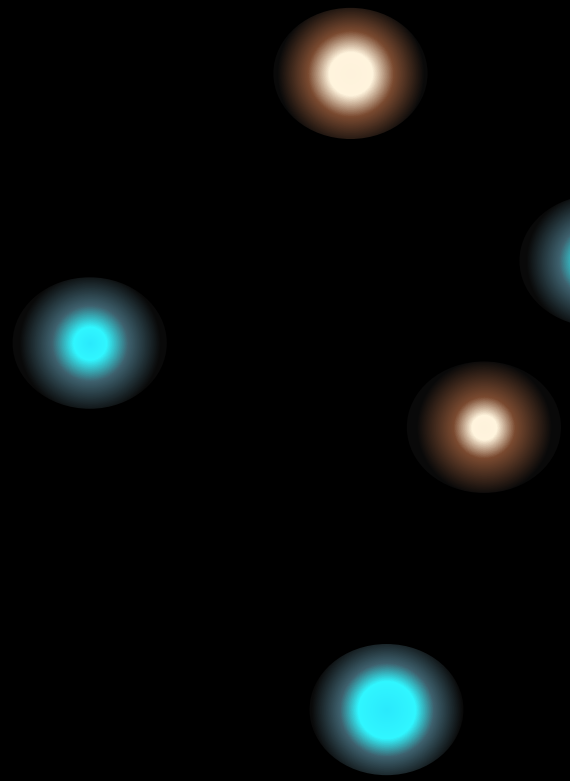


Global Navigation Satellite Systems

An very short introduction to Global Navigation Satellite Systems (GNSS)

Rupert Brown
rbrown@frontiersi.com.au

FrontierSI
December 2021


+61 406 966 992


https://frontiersi.com.au/


Door 34, Goods Shed, Village Street, Docklands, VIC, 3008, Australia

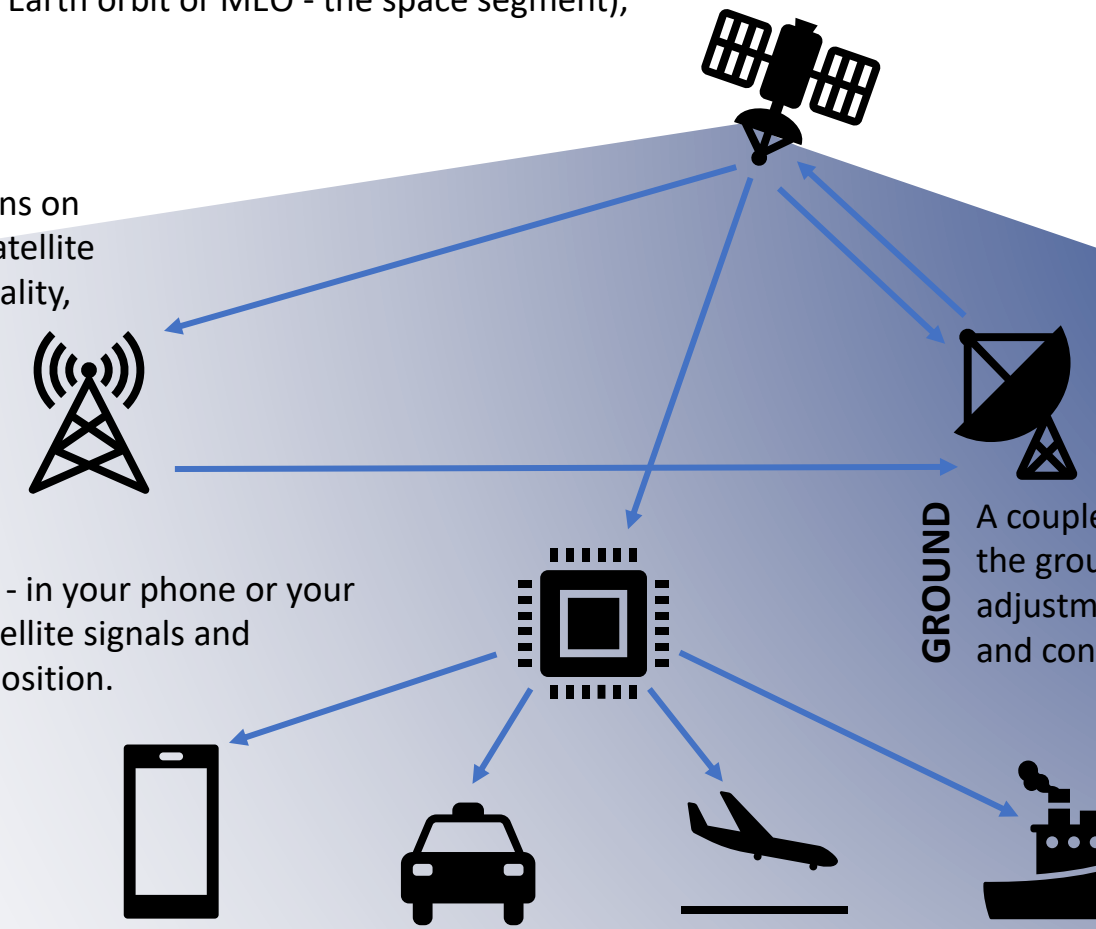
Global Navigation Satellite Systems

A global navigation satellite system consists of:

SPACE A constellation of nominally 24 satellites moving around the Earth twice a day in three distinct orbits that are inclined to each other, and at approximately 20,000km above the Earth's surface (medium Earth orbit or MEO - the space segment),

There can be as many as 30 satellites in a constellation – 24 plus "spares" in space.

GROUND A number of monitoring stations on the ground that listen to the satellite broadcasts and assess their quality,



GROUND A couple of control stations on the ground that can make adjustments to satellite orbits and configurations,

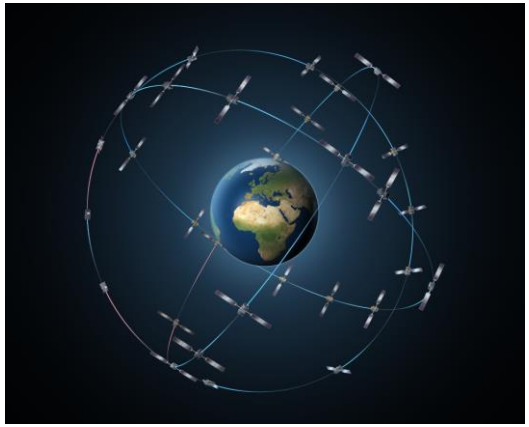
USER The receivers on the ground - in your phone or your car - that can pick up the satellite signals and decode them to give you a position.

Rupert W Brown December 2021

GNSS Components

SPACE

A Russian GLONASS GNSS satellite



The Galileo GNSS satellite constellation

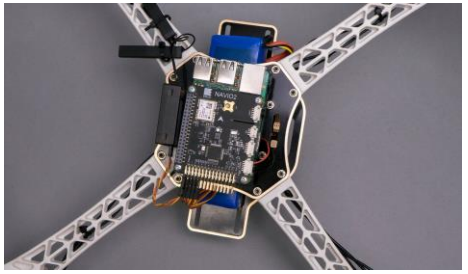
GROUND

An Australian GNSS monitoring station

A GPS Control Station

USER

A GNSS car navigation system



A GNSS enabled drone autopilot

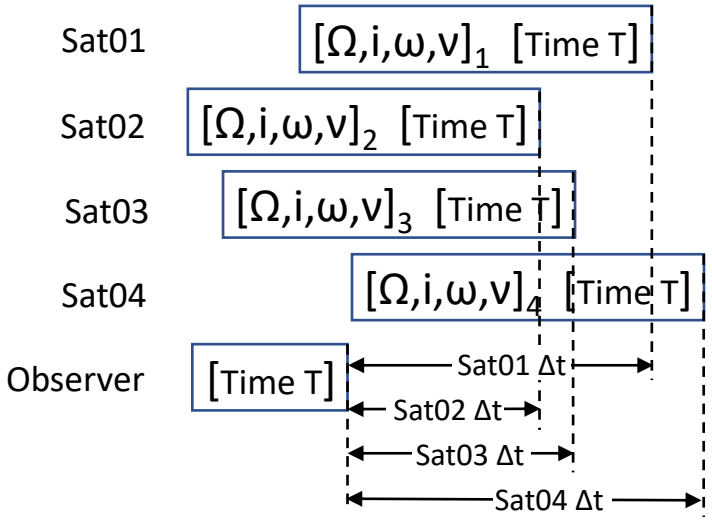
Rupert W Brown December 2021

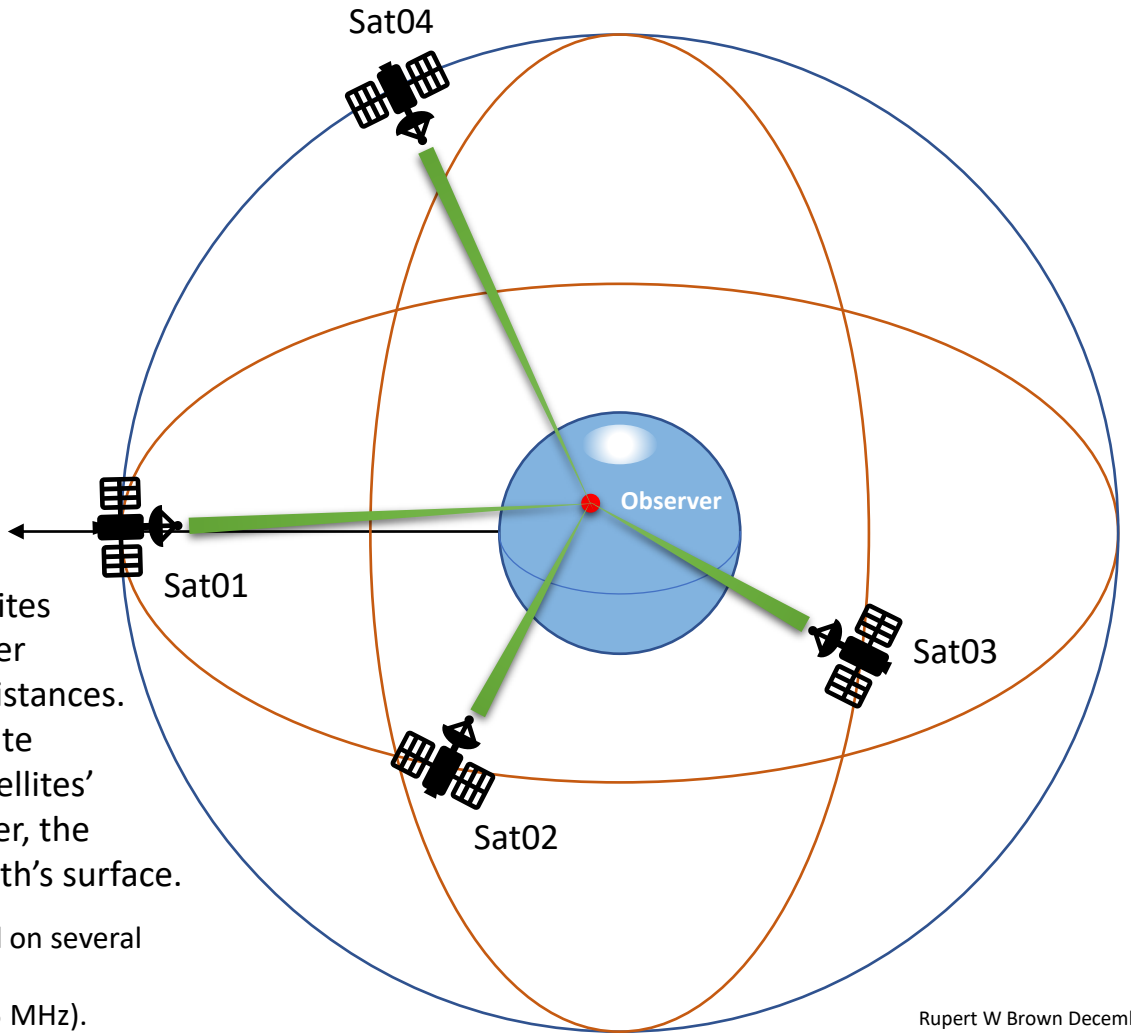
Position: determining a position on Earth using GNSS radio signals

These symbols represent parameters that define a satellite's orbit.

- Ω Argument of the ascending node (Aries)
- i Angle of inclination
- ω Argument of perigee
- ν True anomaly

Position and time messages sent from the satellites are received by the Observer at different times.



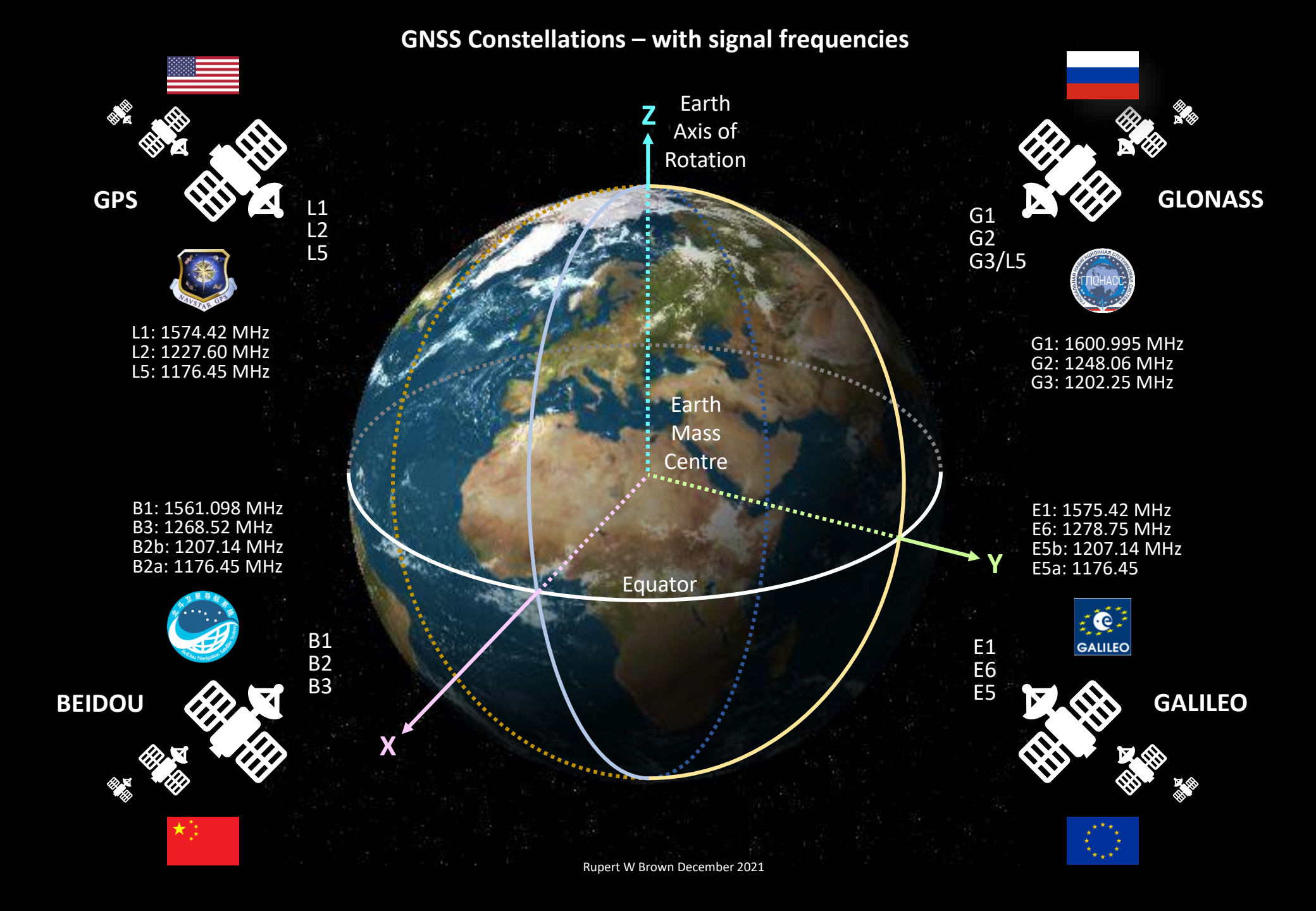


Messages sent at the same time by the satellites are received at different times by the Observer because the signals have to travel different distances. These time differences can be used to calculate those distances. With a knowledge of the satellites' positions and their distance from the Observer, the Observer can calculate its position on the Earth's surface.

The messages are complex in nature and transmitted on several frequencies including the three L bands:
L1 (1575.42 Mhz), L2 (1227.60 MHz) and L5 (1176.45 MHz).

Rupert W Brown December 2021

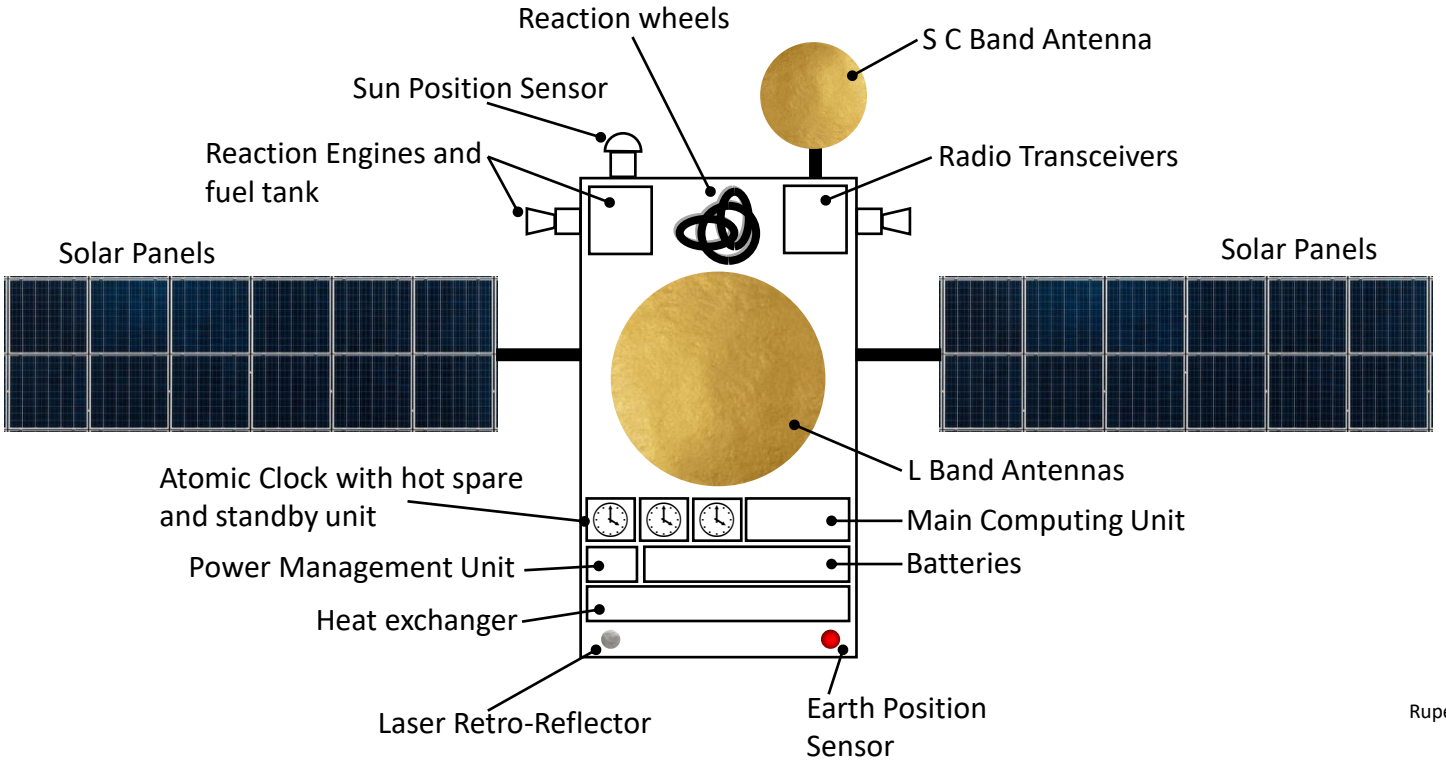
GNSS Constellations – with signal frequencies



Rupert W Brown December 2021

The space segment - satellite

A representation – not an accurate depiction – of a GNSS satellite.



Rupert W Brown December 2021

Electrical power is generated by the **Solar Panels**. The **Power Management Unit** controls the distribution of power to onboard systems and the **Batteries**. The **Batteries** ensure that the satellite continues to operate when the solar panels are not in sunlight. The **Sun Position Sensor** identifies the direction of the Sun.

The **Reaction Engines** are used to maintain the satellite's position in orbit as part of a constellation. A satellite typically carries a finite amount of fuel which is depleted over time and restricts the satellite's useful working life. The **Reaction Wheels** use angular momentum to adjust the satellite's orientation.

A **Radio Transceiver** creates the L Band signals – the positioning signals – which are broadcast via the **L Band Antennas**. The fully redundant **Atomic Clocks** provide vital timing data to create the positioning signals. The **Earth Position Sensor** ensures that the positioning signals are pointed at the Earth.

The **Main Computing Unit**, working with the **S and/or C Band Antenna** receives and processes telemetry, tracking and command data to keep the satellite working correctly and in the right place. The **Laser Retro-Reflector** is used by ground based ranging lasers to determine the satellite's position and latitude.


FrontierSI – we know where