GALILEO : EU SATELLITE NAVIGATION SYSTEM

Galileo is Europe's global navigation satellite system, providing a highly accurate, guaranteed global positioning service under civilian control. Currently providing Initial Services, Galileo is interoperable with GPS and Glonass, the US and Russian global satellite navigation systems respectively. Galileo is the outcome of a partnership between ESA and European commission.

APPLICATIONS

OPEN SERVICE- The navigation signals will be accessible by the general public free of cost, providing improved global positioning.

SAFETY OFFLINE SERVICES - By improving GPS signals, it offers guaranteed increased in performance for the critical transport applications such as aviation and precision maritime navigation. It includes a key 'integrity' function to warn users promptly if the system become less reliable.

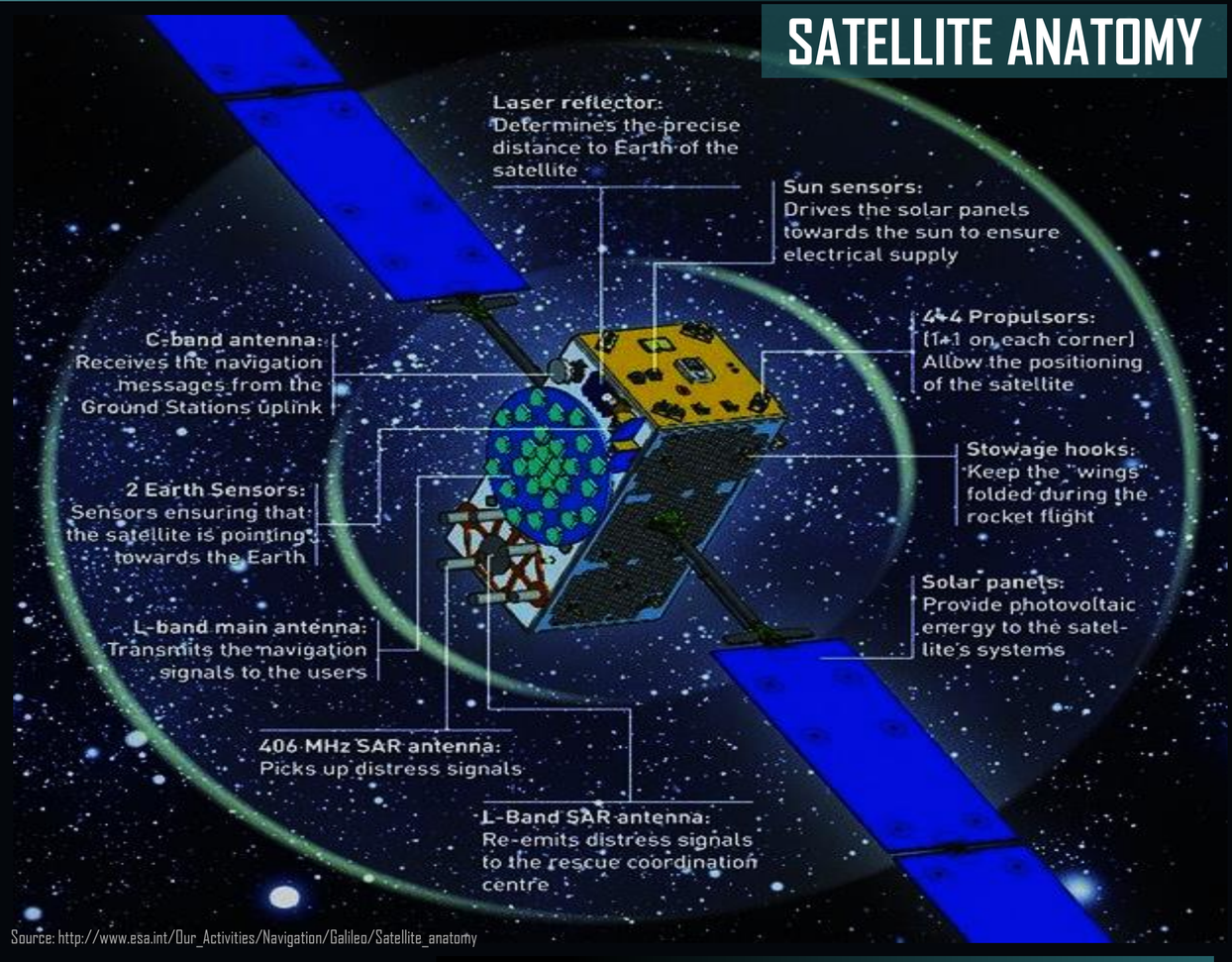
SEARCH AND RESCUE SERVICES - Galileo will contribute to the international Cospas-Sarsat system for search and rescue. A distress signal will be relayed to the Rescue Coordination Centre, and Galileo will inform user that their situation has been detected.

PUBLIC REGULATED SERVICE - Two encrypted signals with controlled access for specific users such as governmental bodies.

COMMERCIAL SERVICES - Galileo will provide a signal for high data throughput and highly accurate authenticated data, particularly interesting for professional users.

TRANSPORT - In road transport, Galileo's highly accurate and reliable signals play an important role in fleet management, delivering the vehicle's positioning on a map and helping to locate specific shipments. Its signals deliver similar benefits in aviation, maritime, rail, and even pedestrian traffic.

SATELLITE ANATOMY



Source: http://www.esa.int/Our_Activities/Navigation/Galileo/Satellite_anatomy

SPACE SEGMENT

Constellation

When Galileo is fully operational, there will be 24 satellites plus spares in Medium Earth Orbit (MEO) at an altitude of 23 222 kilometers. Eight active satellites will occupy each of three orbital planes inclined at an angle of 56° to the equator. The satellites will be spread evenly around each plane and will take about 14 hours to orbit the Earth. Two further satellites in each plane will be a spare; on stand-by should any operational satellite fail. The result will be Europe's largest ever fleet of satellites, operating in the new environment of medium-Earth orbit.

Test Satellites

The first Galileo test satellite, the Glove-A was launched on 28th Dec, 2005 and the second test satellite, the Glove-B was launched in April 2008. After successful completion of In-Orbit Validation(IOV) phase, subsequent satellites were launched.

In-Orbit Validation(IOV) Satellites

Galileo's first launch took place on 21 October 2011: a Soyuz rocket from French Guiana launched two satellites, with two more following on 12 October 2012. These first four Galileo satellites in orbit represented the operational nucleus of the full 24-satellite constellation. The first four satellites were known as the In-Orbit Validation (IOV) satellites.

Full Operational Capability(FOC) Satellites

The fifth and sixth Galileo satellites launched together on 22 August 2014 – the first of the Full Operational Capability (FOC) satellites – ended up in an elongated orbit travelling up to 25 900 km above Earth and back down to 13 713 km.

On 27 March 2015, with the launch of the next two FOC satellites, bringing the total number of satellites in space to eight.

Further two-satellite launches took place on 11 September 2015, 17 December 2015 and 24 May 2016. The first four-satellite launch by Ariane 5 took place on 17 November 2016, with two further Ariane 5 launches scheduled to take place during the following two years.

FACTS AND FIGURES

Satellites 1-4	
Launch mass:	700 kg
Size:	2.74 x 14.5 x 1.59 m (solar wings deployed)
Available Power:	1420 W
Satellites 5-26	
Launch mass:	732.8 kg
Size:	2.5 x 14.67 x 1.1 m (solar wings deployed)
Available Power:	1900 W
Satellites 27-34	
Launch mass:	700 kg approx.
Size:	2.5 x 14.67 x 1.1 m (solar wings deployed)
Available Power:	1900 W
Launch vehicles:	Soyuz ST-B launcher (two-satellite configuration) or Ariane-5 (four-satellite configuration)
Navigation payload:	Passive hydrogen maser atomic clocks (two); Rubidium atomic clocks (two); Clock monitoring and control unit; Navigation signal generator unit; L-band antenna for navigation signal transmission; C-band antenna for uplink signal detection; Two S-band antennas for telemetry and tele commands; Search and rescue antenna.
Orbit:	Circular Medium-Earth orbit, 23 222 km (satellites 5-6 in elongated orbit of 25 900 km apogee and 17 200 km perigee due to launch anomaly)
Orbital inclination:	56°
Operational lifetime:	more than 12 years

GALILEO'S CLOCK

Galileo's highly-accurate clocks are at the heart of the system. Each satellite emits a signal containing the time it was transmitted and the satellite's orbital position. The passive hydrogen maser clock is the master clock on board each satellite. It is an atomic clock which uses the ultra stable 1.4 GHz transition in a hydrogen atom to measure time to within 0.45 nanoseconds over 12 hours.

GROUND SEGMENT

A network of ground stations continuously checks each satellite's clock against Galileo System Time. Accurate to 28 billionths of a second, GST is generated by the Precise Timing Facilities at the Galileo Control Centres in Fucino, Italy and Oberpfaffenhofen, Germany, which are in turn cross-checked for alignment to the International Coordinated Universal Time by a group of European timing laboratories.

Galeleo's Ground Segment

The Galileo Ground Segment necessary is one of the most complicated developments undertaken by Europe, having to fulfil strict levels of performance, security and safety:

- **Ground Mission Segment** (GMS) - It provides cutting-edge navigation performance at high speed around the clock, processing data from a worldwide network of stations. GMS has two million lines of software code, 500 internal functions, 400 messages and 600 signals circulating through 14 different elements.
- **Ground Control Segment** (GCS) - It monitors and controls the constellation with a high degree of automation.
- **Telemetry, Tracking and Command Stations** two, at Kiruna in Sweden and Kourou in French Guiana.
- **Uplink Stations** a network of stations to uplink the navigation and integrity data.
- **Sensor Stations** A global network providing coverage for clock synchronization and orbit measurements.
- **Data Dissemination Network** interconnecting all Galileo ground facilities.

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