Galileo positioning system

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The **Galileo positioning system**, referred to simply as **Galileo**, is a proposed Global Navigation Satellite System, to be built by the European Satellite Navigation Industries for the European Union (EU) and European Space Agency (ESA) as an alternative to the United States operated Global Positioning System (GPS) and the Russian GLONASS. Galileo Operating Company, the concession holder and private consortium that was to run Galileo, was to have its main headquarters in Toulouse, France, with some specialized command centers also located in Munich (performance control), London (system operations), Rome (performance control), and Madrid (Safety of Life signals and redundancy control).[1] It was reported on 18 May 2007 that, at the recommendation of Transport Commissioner Jacques Barrot, the EU will take direct control of the Galileo project from the private sector.[2]

Galileo is tasked with multiple objectives including the following: to provide a higher precision to all users than is currently available through GPS or GLONASS, to improve availability of positioning services at higher latitudes, and to provide an independent positioning system upon which European nations can rely even in times of war or political disagreement. The current project plan has the system as operational by 2011–12, three or four years later than originally anticipated.

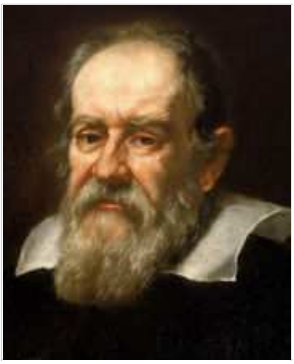
It is named after the Italian astronomer Galileo Galilei. The Galileo positioning system is referred to as "Galileo" instead of as the abbreviation "GPS" to distinguish it from the existing United States system.

Contents

History

The first stage of the Galileo programme was agreed upon officially on May 26, 2003 by the European Union and the European Space Agency. In 1999, the different concepts (from Germany, France, Italy and the United Kingdom) for Galileo were compared and reduced to one by a joint team of engineers from all four countries. The system is intended primarily for civilian use, unlike the United States system, which the U.S. military runs and uses on a primary basis. The U.S. reserves the right to limit the signal strength or accuracy of the GPS systems, or to shut down public GPS access completely (although it has never done the latter), so that non-military users cannot use it in time of conflict. Until 2000, the precision of the signal available to non-military users was limited (a process known as *selective availability*). The European system will only be subject to shutdown for military purposes in extreme circumstances (though it may still be jammed by anyone with the right equipment), will provide a significant improvement to the signal available from GPS, and will, upon completion, be available at its full precision to all users, both civil and military.

The European Commission had some difficulty trying to secure funding for the next stage of the Galileo project. European states were wary of investing the necessary funds at a time of economic difficulty, when national budgets were being threatened across Europe. Following the September 11, 2001 attacks, the United States Government wrote to the European Union opposing the project, arguing that it would end the ability of the United States to shut down GPS in times of military operations. On January 17, 2002 a spokesman for the project somberly stated that, as a result of U.S. pressure and economic difficulties, "Galileo is almost dead." [3]


Galileo Galilei

A few months later, however, the situation changed dramatically. Partially in reaction to the pressure exerted by the U.S. Government, European Union member states decided it was important to have their own independent satellite-based positioning and timing infrastructure. All E.U. member states became strongly in favour of the Galileo system in late 2002 and, as a result, the project actually became over-funded, which posed a completely new set of problems for the European Space Agency, as a way had to be found to convince the member states to reduce the funding.

The European Union and the European Space Agency then agreed in March 2002 to fund the project, pending a review in 2003 (which was finalised on May 26, 2003). The starting cost for the period ending in 2005 is estimated at €1.1 billion. The required satellites—the planned number is 30 — will be launched throughout the period 2006–2010 and the system will be up and running and under civilian control from 2010. The final cost is estimated at €3 billion, including the infrastructure on Earth, which is to be constructed in the years 2006 and 2007. Private companies and investors will invest at least two-thirds of the cost of implementation; the EU and ESA will divide the remaining cost. An encrypted higher-bandwidth *Commercial Service* with improved accuracy will be available at an extra cost, while the base *Open Service* will be freely available to anyone with a Galileo-compatible receiver.

In June 2004, in a signed agreement with the United States, the European Union has agreed to switch to a range of frequencies known as "Binary Offset Carrier 1.1," which will allow both EU and US forces to block each other's signals in the battlefield without disabling the entire system. The European Union also agreed to address the "mutual concerns related to the protection of allied and U.S. national security capabilities."[4]

According to the Associated Press, the Galileo project is "in deep crisis and will require more public funds to get back on track."[5] German Transport Minister Wolfgang Tiefensee, speaking on behalf of the EU, said he had "little hope left" the consortium will end the infighting by the May 10, 2007. On May 16, 2007, the European Commission will present a proposal on how to overhaul the project. Only one of the 30 planned satellites has been successfully launched. The future is in doubt until the EU decides how to pay for the system.

[the previous information is contradictory]

International involvement

In September 2003, China joined the Galileo project. China will invest €230 million (USD 302 million, GBP 155 million, CNY 2.34 billion) in the project over the next few years.[6]

In July 2004, Israel signed an agreement with the EU to become a partner in the Galileo project.[7]

On 3 June 2005 the EU and Ukraine signed an agreement for Ukraine to join the project, as noted in a press release.[8]

On September 7, 2005, India signed an agreement to take part in the project and to establish a regional augmentation system based on the European Geostationary Navigation Overlay Service (EGNOS).

As of November 2005, Morocco and Saudi Arabia have also joined the programme.

On January 12, 2006 South Korea joined the programme.

There is speculation that further countries might join the Galileo project, including Argentina, Australia, Brazil, Canada, Chile, Japan, Malaysia, Mexico, Norway, Pakistan and Russia.

Political implications of Galileo project

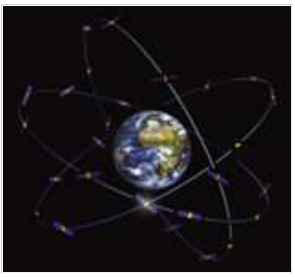
The neutrality of this article or section is disputed.
Please see the discussion on the talk page.

As well as being an impressive technological achievement and a hugely practical tool, Galileo will be a political statement of European

independence from the United States and its GPS system. A strong motivator for an independent system is that, though GPS is now widely used worldwide for civilian applications, it is a military system, which as recently as 2000 had selective availability that may be enabled in particular areas of coverage during times of war. Galileo's proponents argue that civil infrastructure, including aeroplane navigation and landing, should not rely solely upon GPS.

System description

Galileo satellites



Galileo was initiated by the EU and ESA

- 30 spacecraft
- orbital altitude: 23 222 km (MEO)
- 3 orbital planes, 56° inclination (9 operational satellites and one active spare per orbital plane)
- satellite lifetime: >12 years
- satellite mass: 675 kg
- satellite body dimensions: 2.7 m x 1.2 m x 1.1 m
- span of solar arrays: 18.7 m
- power of solar arrays: 1500 W (end of life)

Services

There will be four different navigation services available:

- The **Open Service** (**OS**) will be free for anyone to access. The OS signals will be broadcast in two bands, at 1164–1214 MHz and at 1563–1591 MHz. Receivers will achieve an accuracy of <4 m horizontally and <8 m vertically if they use both OS bands. Receivers that use only a single band will still achieve <15 m horizontally and <35 m vertically, comparable to what the civilian GPS C/A service provides today. It is expected that most future mass market receivers, such as automotive navigation systems, will process both the GPS C/A and the Galileo OS signals, for maximum coverage.

- The encrypted **Commercial Service (CS)** will be available for a fee and will offer an accuracy of better than 1 m. The CS can also be complemented by ground stations to bring the accuracy down to less than 10 cm. This signal will be broadcast in three frequency bands, the two used for the OS signals, as well as at 1260–1300 MHz.

- The encrypted **Public Regulated Service** (**PRS**) and **Safety of Life Service** (**SoL**) will both provide an accuracy comparable to the Open Service. Their main aim is robustness against jamming and the reliable detection of problems within 10 seconds. They will be targeted at security authorities (police, military, etc.) and safety-critical transport applications (air-traffic control, automated aircraft landing, etc.), respectively.

In addition, the Galileo satellites will be able to detect and report signals from Cospas-Sarsat search-and-rescue beacons in the 406.0–406.1 MHz band, which makes them a part of the Global Maritime Distress Safety System.

Galileo satellite test beds

GIOVE-A launch

In 2004 the Galileo System Test Bed Version 1 (GSTB-V1) project validated the on-ground algorithms for Orbit Determination and Time Synchronization (OD&TS). This project, led by ESA and European Satellite Navigation Industries, has provided industry with fundamental knowledge to develop the mission segment of the **Galileo positioning system**.[9]

The European Space Agency and the Galileo Joint Undertaking successfully launched the first Galileo In-Orbit Validation Element test satellite, GIOVE-A, on 28 December 2005. GIOVE-A was built by Surrey Satellite Technology Ltd (SSTL). Operation of GIOVE-A ensured that Galileo meets the frequency-filing allocation and reservation requirements for the International Telecommunication Union (ITU), a process that was required to be complete by June of 2006.

GIOVE-B, built by European Satellite Navigation Industries, has a more advanced payload than GIOVE-A. After technical problems were encountered, GIOVE-B is now targeted for launch at end of 2007.[10]

The GIOVE-A2 satellite, to be built by SSTL, will be ready for launch in the second half of 2008, to ensure continuous reservation of Galileo frequency use with the ITU.[11]

These testbed satellites will be followed by four In-Orbit Validation (IOV) Galileo satellites that will be much closer to the final Galileo positioning satellite design.

From mid-2006, the GIOVE Mission[12][13] (GIOVE-M) segment is exploiting the GIOVE-A satellite to provide experimental results based on real data to be used for risk mitigation for the IOV satellites that will follow on from the testbeds. The GIOVE Mission will also provide experimentation results based on GIOVE-B and GIOVE-A2 satellites. It is operated by ESA and European Satellite Navigation Industries.

Science projects using Galileo

In July 2006, an international consortium of universities and research institutions embarked on a study of potential scientific applications of the Galileo constellation. This project, dubbed GEO6 (http://www.gnss-geo6.org/) , is a 360-degree study oriented to the scientific community in its broader sense, aiming to define and implement new applications of Galileo.

Among the various GNSS users identified by the Galileo Joint Undertaking (http://www.galileoju.com) , the GEO6 (http://www.gnss-geo6.org/) project addresses the Scientific User Community (UC).

The GEO6 (http://www.gnss-geo6.org/) project aims at fostering possible novel applications within the scientific UC of GNSS signals, and particularly of Galileo.

On the basis of the potential number of users, potential revenues for Galileo Operating Company or Concessionaire (GOC), international relevance, and level of innovation, a set of Priority Applications (PA) will be selected by the consortium and they will be developed within the time frame of the same Project.

These applications will help to increase and optimize the use of the EGNOS services as well as the opportunities offered by the Galileo Signal Test-Bed (GSTB-V2) and the Galileo (IOV) phase.

See also

- European Geostationary Navigation Overlay Service
- Commercialization of space
- Multilateration - the mathematical technique used for Galileo positioning

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External links

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Developmental — **Beidou** | **Galileo** | **IRNSS**

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