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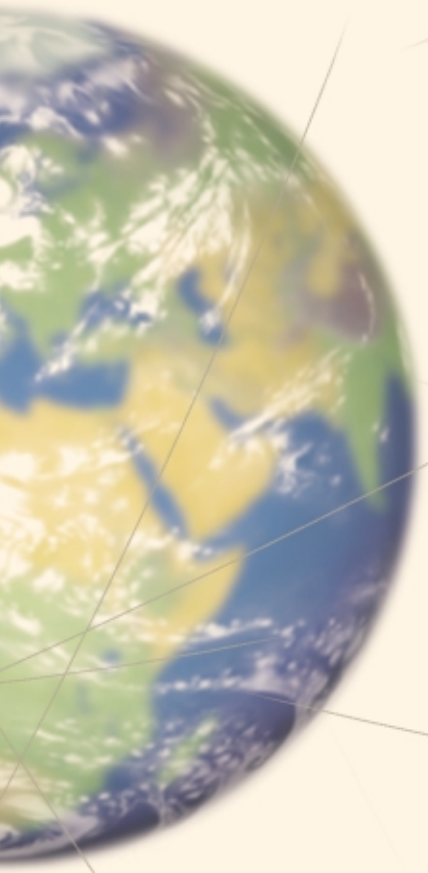
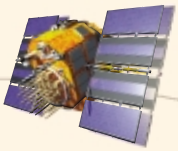
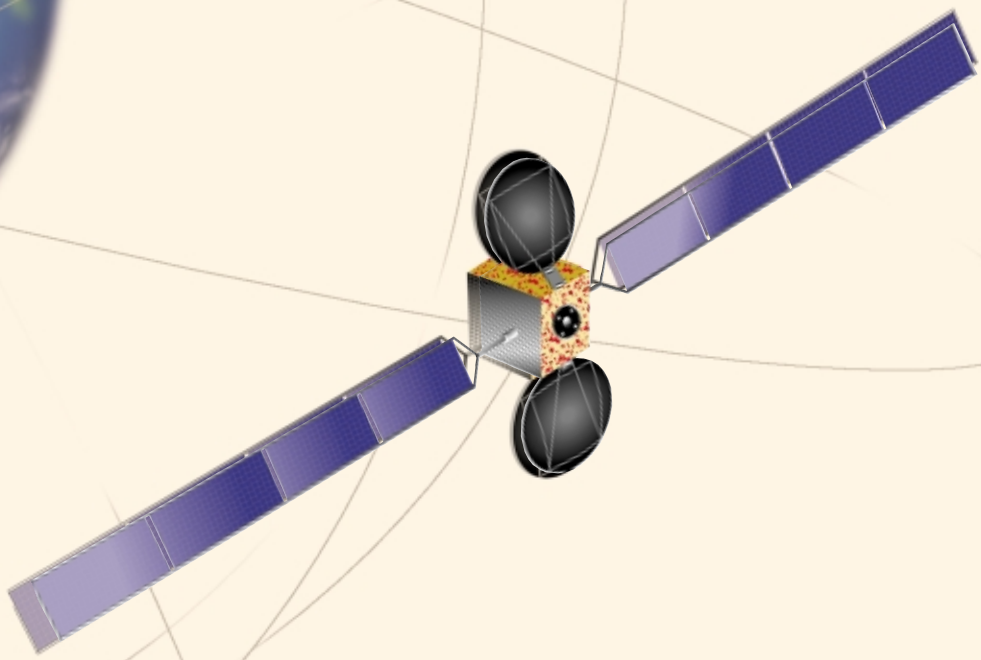


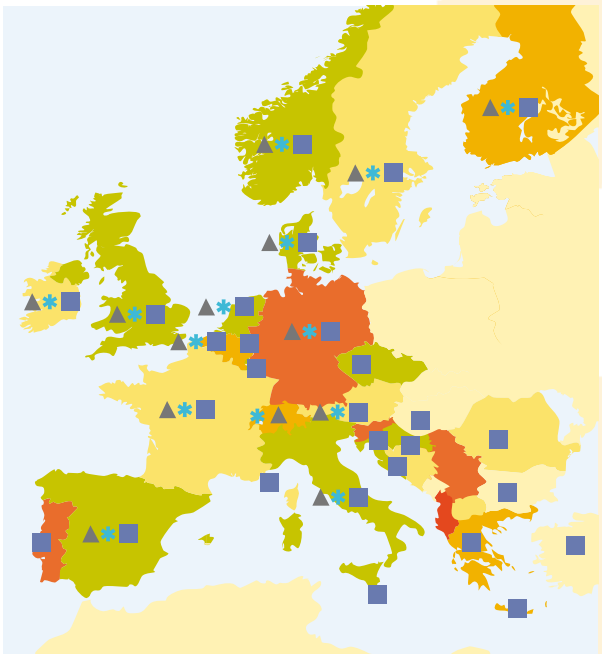


EGNOS

The European Geostationary Navigation Overlay Service: Europe's First-Generation Regional Contribution to GNSS



Successful tripartite cooperation under the European banner



European Community Member States ▲
Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden and the United Kingdom.

ESA Member States *
Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, The Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom (Cooperation agreements with Canada and Portugal).

Eurocontrol Member States ■
Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Malta, Monaco, The Netherlands, Norway, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

European Community

The European Commission (EC) is the European Community's executive body. It has a President and 20 Commissioners appointed by the 15 Member States. It implements and monitors European Union programmes. It drafts legislation aimed at European unification for submission to the European Parliament and the Council of Ministers, mainly concerning agriculture, structural funds, transport, telecommunications, and research and development. GNSS is representative of one of its strategic fields of activity.

ESA

The European Space Agency (ESA) currently has 14 Member States and its role is to provide for and promote, for exclusively peaceful purposes, cooperation among European States in space research, technology and applications. To achieve this, ESA was asked to define and put into effect a long-term European space policy that would enable Europe to become and remain competitive in all fields of space technology. ESA also carries out a policy of cooperation with various partners, knowing that pooling of resources and sharing of work will boost the effectiveness of its programmes. Its main areas of activity are space science, Earth observation, telecommunications, manned spaceflight and space transportation systems.

Eurocontrol

The European Organisation for the Safety of Air Navigation (Eurocontrol) has 27 Member States. Founded in 1960 to oversee air traffic control in the upper air space of Member States, Eurocontrol today has as its most important goal the development of a coherent and coordinated air traffic control system in Europe. Its primary objectives are to:

- manage the implementation of the European Air Traffic Control Harmonisation and Integration Programme (EATCHIP), as well as a series of associated concepts and future strategies, on behalf of States belonging to the European Civil Aviation Conference (ECAC)
- operate the Central Flow Managment Unit (CFMU), so as to make optimum use of European air space and to prevent air traffic congestion
- implement short- and medium-term actions to improve the coordination of air traffic control systems throughout Europe
- carry out research and development work aimed at increasing air-traffic-control capacity in Europe.

GNSS

GNSS: The Global Navigation Satellite System

The European Space Agency (ESA), the European Community (EC), and the European Organisation for the Safety of Air Navigation (Eurocontrol), together making up the 'European Tripartite Group' (ETG), have decided to contribute to the development of a global positioning and navigation satellite system known as GNSS.

The development programme is to be carried out in two main stages:

– GNSS-1, the first-generation system, will be based on signals received from the GPS and GLONASS constellations, and an augmentation of those systems, EGNOS, similar to the systems being developed by the USA (WAAS) and Japan (MSAS).

– GNSS-2, the second-generation system, should provide services to civil users and will be under civil operation and control. Galileo is Europe's contribution to this system.

The GNSS programme is strategically important to Europe in terms of safety, independence, economic prosperity, promotion of industry, employment and quality of life.

EGNOS

Space technology has at last been recognised as having a key role to play in maximising safety in the transport of passengers and goods.

GNSS
Global Navigation Satellite System

GPS
Global Positioning System

GLONASS
GLObal NAvigation Satellite System

EGNOS
European Geostationary Navigation Overlay Service

MSAS
Multi-transport Satellite based Augmentation System

WAAS
Wide Area Augmentation System

Galileo
Europe's contribution to GNSS-2

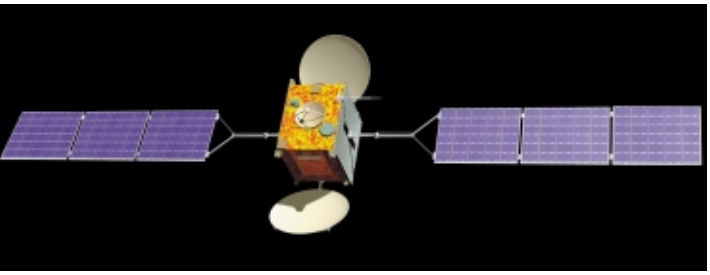
Inmarsat
International Maritime Satellite Organisation

Artemis
ESA's Advanced Relay and Technology Mission Satellite

EGNOS: the European complement to the GPS and GLONASS systems

GNSS-1, the first generation of GNSS, is a combination of:
– the American GPS, made up of 24 satellites flying at 20 000 km altitude
– the Russian GLONASS, made up of 24 satellites flying at 19 100 km altitude
– three interoperable satellite-based augmentation systems developed by the USA (WAAS), Japan (MSAS) and Europe (EGNOS).

EGNOS is operating navigation payloads flown on geostationary satellites. Its role is to augment the performance of the GPS and GLONASS systems by improving their service integrity and the accuracy of their measurements. These two systems were originally designed for military purposes and their services were subsequently offered to civilian users, but with deliberate performance downgrading in the case of GPS. This means that the information supplied does not provide the positioning accuracy required for safety-critical transport applications, so that additional equipment needs to be used on the ground.



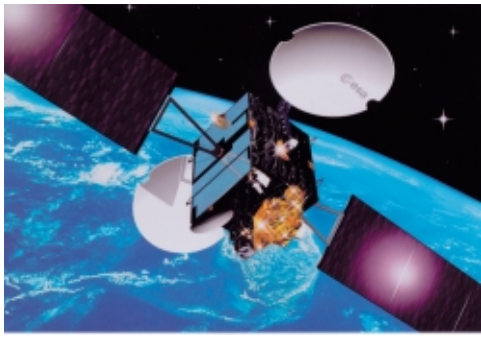
Artist's impression of an Inmarsat-3 satellite

Better navigation performance for improved safety

Designed to make transport by air, sea and land safer, EGNOS will give users access to a variety of services:
– the Ranging Service: EGNOS will provide positioning information similar to that from GPS
– the Integrity Service: in the event of an anomaly in data transmitted by a GPS or GLONASS satellite in view from the service area, EGNOS will send an alarm signal in less than six seconds, whereas hitherto these satellites could transmit faulty information for several minutes or even hours before it was neutralised or reconfigured
– the Differential Correction Service: EGNOS will raise the accuracy of measurements obtained from the GPS and GLONASS satellites by distributing an improved ephemeris for the satellites under its control, and reducing ionospheric errors, thus eliminating the effects of selective GPS downgrading
– greater availability and continuity of service: the EGNOS satellites are in a geostationary orbit at a higher altitude than the GPS and GLONASS constellations, and will provide coverage of the European region around the clock
– a time standard: EGNOS will broadcast time information synchronised to UTC (Universal Time Coordinates) with unprecedented accuracy.

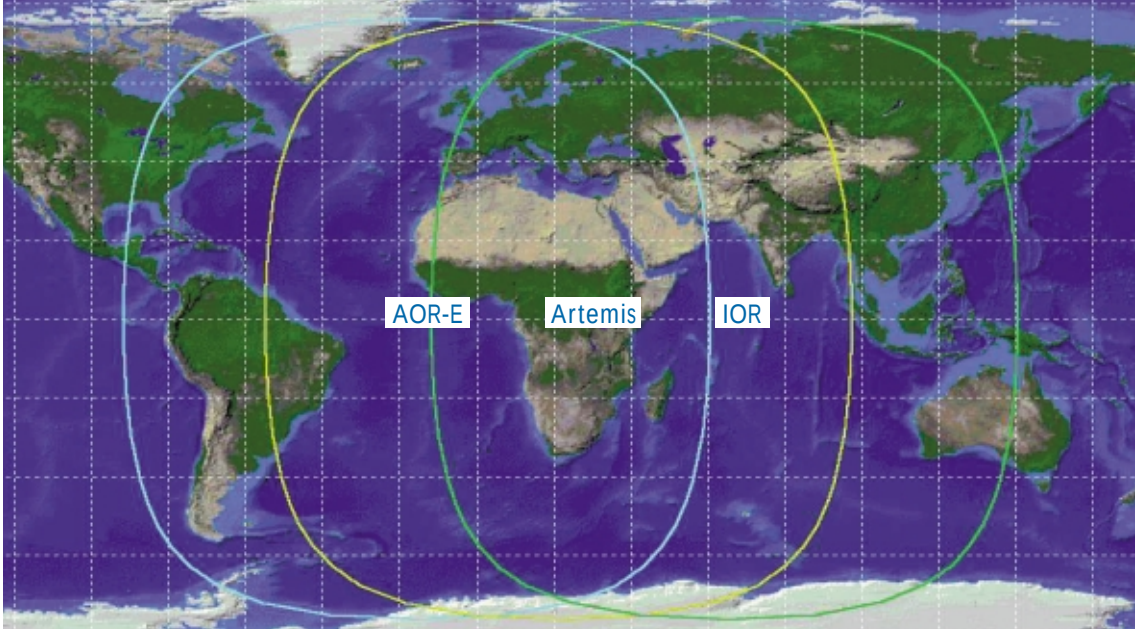
A flexible system for all modes of transport

The EGNOS system is based on a specific signal that allows the same user functionalities to be suitable for aircraft, ships, trucks etc. This is a key feature of GNSS. Similar systems are under development in various parts of the World, but their services will be dedicated exclusively to air navigation: WAAS in North America and MSAS in Japan.



Artist's impression of ESA's Artemis satellite

Another advantage is that EGNOS users can benefit from the combination of data obtained from both GPS and GLONASS satellites whereas WAAS and MSAS will rely exclusively on GPS data



EGNOS coverage area
AOR-E : Inmarsat-3 Atlantic Ocean Region East
Artemis : ESA's experimental telecommunication satellite
IOR : Inmarsat-3 Indian Ocean Region

From East to West: an expanding coverage area

EGNOS will be operational by early 2003.

To cover all the countries belonging to the European region, two Inmarsat-3 satellites will be used in the EGNOS system, one stationed over the eastern part of the Atlantic Ocean, the other over the Indian Ocean. A third satellite, Artemis, designed by ESA, will be added to the EGNOS system. Artemis will be launched in early 2000 and stationed over Africa.

EGNOS gives a warning of any faulty GPS or GLONASS information within six seconds.

With the coverage provided by these Inmarsat-3 satellites, soon to be joined by Artemis, many countries outside the European region will also be able to take advantage of the EGNOS system. Africa, the Middle East, North and Central Asia (e.g. India) and Latin America could benefit greatly from the expansion of the EGNOS ground infrastructure to their region. This could provide early operational benefits where navigation infrastructure is lacking.

Complementing the GPS, the EGNOS, WAAS and MSAS systems are interoperable.

The European Space Operations Centre (ESOC), in Darmstadt (D)

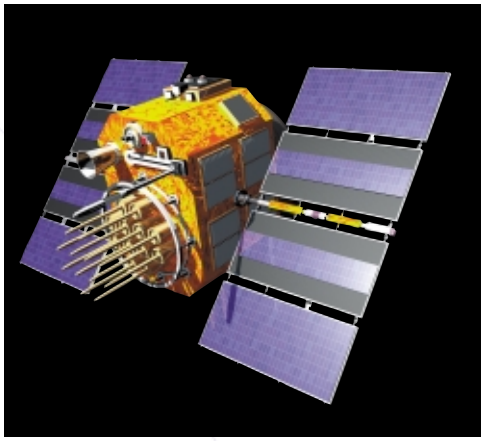
EGNOS ground infrastructures

The ground facilities of the EGNOS system, which will link up with the Inmarsat-3 and Artemis geostationary satellites, will consist of:

- some 30 Ranging and Integrity Monitoring Stations (RIMSs) to receive data from the GPS and GLONASS satellites and relay it to a mission control centre
- four Mission Control Centres (MCCs), located in Spain, the United Kingdom, Germany and Italy, to process data, determine corrections to be made, and control the overall system
- six Navigation Land Earth Stations (NLESs) located in France, Italy, the United Kingdom, Germany and Spain to uplink corrections to the Inmarsat-3 and Artemis satellites; for each geostationary satellite in the EGNOS system, two NLESs will be used, one backing up the other, and a seventh NLES in Portugal for test and validation purposes
- a Performance-Assessment and Check-out Facility (PACF) located in France
- an Applications-Specific Qualification Facility (ASQF) located in Spain

Adaptability, modularity and genuine partnerships

The design of EGNOS is modular, so as to be able to accommodate any specific requirements of regions



Artist's impression of a GPS satellite

outside Europe wishing to avail themselves of its services. Very close partnerships are already being developed in order to enable the various regions interested to obtain full details of the capabilities of EGNOS, specify their requirements and, assuming terms are agreed, take a hand in shaping the system's operations. Each will be a genuine partner and will thus be able to exercise quality control over the system. Quality is paramount where human lives are at stake. The European Community has financial resources available which might be used to help potential partners join the system.

EGNOS

Innovation in air navigation

EGNOS, for which the main market today is represented by airlines, whether public or private, is going to transform air-traffic management. With the services provided by satellite, it is going to become possible for a substantial proportion of air-traffic-control procedures to be conducted from the flight decks of aircraft, regulating the speed of aircraft and distances between them, thus increasing capacity in complete safety, gaining time, saving fuel and therefore reducing costs.

European air-traffic management service providers – AENA in Spain, DFS in Germany, DNA in France, ENAV in Italy, NATS in the United Kingdom, NAV-EP in Portugal and Swisscontrol in Switzerland – are participating in the EGNOS programme and will play a major role in future EGNOS operations.

Same item of equipment for the various flight phases

Information provided by EGNOS will be used during the following phases of flight:

– en route, telling the navigator his exact position
– non-precision approach, when the navigator has to rely on visual guidance
– category-1 precision approach, when visibility is poor.

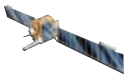
Used during these various phases of flight, EGNOS will reduce the number of items of navigation equipment required, and hence the associated capital expenditure. What is more, EGNOS will enable the many airports that are not currently equipped for poor-visibility landings to offer this facility without having to make the large investments in physical infrastructure that would otherwise be necessary.

A single terminal will be able to receive GPS, GLONASS and EGNOS information.

The accuracy delivered by EGNOS will be better than 7.7 m for a vehicle fitted with GPS alone, and 4 m for one with both GPS and GLONASS.

It is planned to obtain operational approval from the appropriate regulators for EGNOS to be used in many safety-critical applications.

Multiple applications for everyday life



Multimodal applications for everyday life

The applications for navigation and positioning systems extend to many branches of activity. Not only airlines, but companies operating transport services by road, sea, inland waterway or rail need to know where their vehicles are at all times. So do various other services, such as police, ambulance or taxi services. As well as improving safety, EGNOS will be an invaluable aid to management for all transport operators, telling them whenever a consignment has been held up and its exact location. In this way, the customer can be notified of the delay, a breakdown crew could be sent out if necessary, etc.

There is also a long list of applications in activities other than transport: leisure (sailing, climbing, hiking), agriculture (aerial crop-spraying), fisheries (locating shoals of fish), combating fraud, land surveying and timing.

A potential EURO 50 billion market

According to some estimates, the worldwide market for satellite navigation could be worth as much as EURO 50 billion by 2005. The GNSS programme is thus an opportunity for Europe to foster the development of a substantial market with great potential for job creation and new businesses across a wide range of industries.

A European industrial consortium

The EGNOS system is being developed in the framework of ESA's Artes Element-9 Programme by a European industrial consortium led by Alcatel Space Industries and composed of companies from France, Portugal, Spain, Italy, Switzerland, Austria, Germany, The Netherlands, Norway, the United Kingdom and Canada.

EGNOS

A navigation signal generated by the ESTB has been available since February 1999 via the Inmarsat AOR-E satellite.

The ESTB demonstrates EGNOS system operation to users

Europe and regions outside Europe can carry out satellite navigation trials up to precision-approach levels by using the ESTB navigation signal

EGNOS System Test Bed

Within the EGNOS programe, ESA is providing a pre-operational signal-in-space (EGNOS System Test Bed), with several objectives:

– to support the system development and verification engineering
– to demonstrate the operational benefits of EGNOS to user communities
– to prepare for the future operational introduction of EGNOS
– to demonstrate the capacity to expand the EGNOS service outside Europe.

A contract has been placed with Alcatel Space Industries leading a European industrial team in order to develop and integrate the ESTB.

Configuration

The ESTB is based on a network of reference stations spread over Europe and outside Europe. It collects real-time data from GPS, GLONASS and the Inmarsat-3 navigation payloads. These data are transmitted and processed in Hönefoss (N) and at CNES/Toulouse (F). The ESTB signal is broadcast through Inmarsat AOR-E and Inmarsat IOR via, respectively, the Aussaguel (F) and Fucino (I) stations.

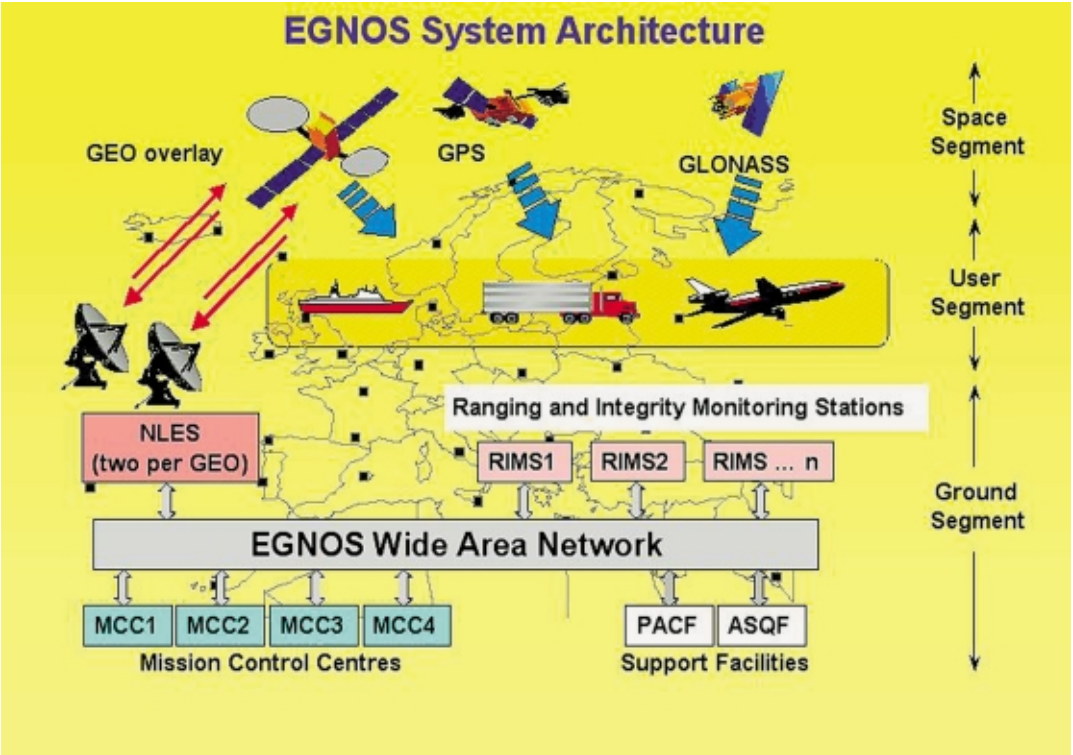
A tool to prepare the future user communities

Companies providing transport services, e.g. airlines, can already prepare for the use of EGNOS. Pre-operational real-time demonstrations of EGNOS will increase awareness of the significant benefits the service provides to potential users.

Satellite navigation trials outside Europe

Transportable reference stations are being developed for international trials under the European Commission's International Satellite Test Bed (ISTB) initiative. These are used together with the ESTB to provide a valid signal-in-space to users outside Europe.

Countries within the coverage of the ESTB, in South America, Africa, the Middle and the Far East, the CIS, and even as far away as Australia, will be able to perform satellite navigation trials for safety-critical aeronautical, maritime and land-mobile applications, using the navigation signal generated by the EGNOS System Test Bed.



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