EN

COMMISSION COMMUNICATION

to the European Parliament and the Council

on

GALILEO

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Summary

Satellite radio navigation is a leading-edge technology which enables the user of a receiver to pick up signals transmitted by several satellites and thereby determine to a high degree of accuracy and from one moment to the next not only the exact time but also his own position in terms of longitude, latitude and altitude.

This technology, currently dominated by the United States with its GPS system and by Russia with its Glonass system and financed and controlled by the military, is notching up success after success and is coming up daily with new applications in the countries of the Union and throughout the world. The uses of these applications and the markets available to them already cover a multitude of activities ranging from all types of transport (positioning and measurement of the speed of moving bodies, insurance, etc.) to medicine (remote treatment of patients, etc.), law enforcement (surveillance of suspects, etc.), customs and excise operations (investigations on the ground, etc.), agriculture (grain or pesticide dose adjustments depending on the terrain, etc.), or ...

In its communication of 10 February 1999 the Commission presented an autonomous programme on satellite radio navigation, known as Galileo, to be developed in four proposed phases, including the definition phase due to be completed at the end of 2000.

The successive phases of the Galileo programme

* **Development and validation phase** (2001-2005)
  - Overall detailed definition of the segments (space, ground, user);
  - Development of the satellites and ground-based components;
  - Validation of the system “in orbit”.
* **Deployment phase** (2006-2007)
  - Production, launching of the satellites;
  - Installation of the complete ground segment;
* **Operating phase** (2008 onwards)

  Replacement of the satellites, operation of the Centres, maintenance.

Stressing the need to give a positive boost to our industries and services, while at the same time ensuring Europe’s independence in a technology as crucial as this one, the Council, in its Resolution of 19 July 1999, called on the Commission to develop a system for civil and global use managed by public civil authorities and offering significant added value in relation to the existing systems, while remaining compatible therewith.

During the definition phase in 2000, the Commission and the European Space Agency have mobilised a very large part of the European space industry as well as a large number of potential service providers with a view to defining the broad outlines of this project.

The present communication sets out the results of this phase. It reaffirms the strategic and economic importance of the project and endorses a proposal that it be continued beyond 2001, albeit subject to certain conditions regarded by the Commission as essential to the successful implementation of Galileo.

These conditions are as follows:

The Commission takes the view that:

– satellite radio navigation is a key technology for the development of our economies and that the deployment, to that end, of a constellation of EU satellites is indispensable to safeguarding our independence;

– cost/benefit studies show Galileo to be cost-effective and sufficiently attractive to obviate the need for any further public funding in the form of subsidies from 2007;

– for the development and validation phase (2001-2005), the essential funding from public subsidies has been so planned that there is no need to call upon additional public contributions, under budgets of the Community or European Space Agency;

– the funding of the deployment phase, comprising the construction and launch of satellites and the establishment of the ground-based infrastructure network, will require private-sector investment of some €1.5 billion; and that an appropriate public–private partnership will be in place in time for the development and validation phase;

– the setting-up of a public-private partnership requires a legal and financial framework as soon as possible.

  - A coordinated, provisional management structure for the Galileo project, involving the Commission and the European Space Agency, should be set up by 2001.

  - The proposals needed to set up the final structure with an investment budget combining all the funds earmarked for the project will be drawn up by the Commission.

  - Egnos should be controlled by this structure.

  - A report will be made each year to the Council and to the European Parliament on the progress made in this area, and on the setting-up of the programme management structures, and to describe the funding of the deployment phase (2006-2007) by December 2004.

Introduction

Satellite radio navigation is a leading-edge technology. It results from the transmission in orbit of signals which indicate the time with extreme accuracy. A receiver picking up these signals from a constellation of several satellites can then determine to a high degree of accuracy and from one moment to the next not only the exact time but also its own position in terms of longitude, latitude and altitude.

This technology, currently dominated by the United States with its GPS system and by Russia with its Glonass system and financed and controlled by the military, is notching up success after success and is coming up daily with new applications in the countries of the Union and throughout the world. The uses of these applications and the markets available to them already extend to a multitude of activities covering, of course, all types of transport (positioning and measurement of the speed of moving bodies, insurance, etc.) but also taking in medicine (remote treatment of patients, etc.), law enforcement (surveillance of suspects, etc.), customs and excise operations (investigations on the ground, etc.), or agriculture (grain or pesticide dose adjustments depending on the terrain, etc.). Furthermore, it is possible for any individual to obtain, for a very modest outlay, a GPS receiver enabling him to pinpoint his position on the road, at sea or in the mountains, albeit without any guarantee of accuracy or continuity of service.

As long ago as March 1998, at the instigation of the Council, the Commission presented in its communication of 10 February 1999[1] an autonomous programme on satellite radio navigation, known as Galileo, to be developed in four proposed phases: a definition phase in 2000, a development and validation phase up to 2005, a deployment phase up to 2007 and an operational phase thereafter.

The Cologne European Council in 1999 and the Feira European Council in 2000 emphasised the strategic importance of Galileo and the need to take a decision on continuing the programme in December 2000.

Stressing the need to give a positive boost to our industries and services, while at the same time ensuring Europe's independence in a technology as crucial as this one, the Council, in its Resolution of 19 July 1999[2], called on the Commission to develop a system for civil and global use managed by public civil authorities and offering significant added value in relation to the existing systems, while remaining compatible therewith.

In their Decision of 23 July 1996[3], on Community guidelines for the development of the trans-European transport network, the European Parliament and the Council included the positioning and navigation systems as integral parts of the network and the related projects as projects of common interest. In their Regulation on the granting of financial aid in the field of trans-European transport networks of 19 July 1999[4], these two institutions also raised the level of Community aid for the positioning and navigation projects to 20%, thereby according them clear priority.

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1 COM(1999)54 final, 10.2.99

2 OJ C 221/01, 3.8.1999

3 Decision No 1692/96/EC of the European Parliament and of the Council – OJ L 228, 9.9.96

4 Regulation (EC) No 1655/1999 of the European Parliament and of the Council amending Regulation (EC) No 2236/95 – OJ L 197/1, 29.7.99

With the support of a large majority of countries on all continents which have supported the development of Galileo as a European system compatible with the existing systems, the European Union has taken steps to ensure that the necessary frequencies were set aside during the World Radiocommunication Conference held in Istanbul in May 2000.

Lastly, the Council has emphasised on a number of occasions the importance of cooperation with the European Space Agency in collaboration with which the Commission has just prepared a communication on space which paves the way over the next few months to the development of a genuine European strategy in the space sector. In this, Galileo will play a key role.

During the definition phase in 2000, the Commission and the European Space Agency have mobilised a very large part of the European space industry as well as a large number of potential service providers with a view to defining the basic elements of this project.

The present communication sets out the results of this phase. It confirms the strategic importance and economic attractions of the project and proposes that it be continued beyond 2001, albeit subject to certain conditions regarded by the Commission as essential to the successful implementation of Galileo.

The successive phases of the Galileo programme

* **Development and validation phase** (2001-2005)
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A challenge facing Europe

In its communication on Galileo of 10 February 1999, the Commission drew attention to a number of major problems which Europe will have to face up to over the next few years.

Satellite radio navigation enables dating signals to be transmitted which represent a vital benchmark for our increasingly integrated economies. The banking, telecommunications and energy networks and the ability to synchronise signals for the transmission of data of all kinds are essential elements in this complex system of interrelationships. Europe (and the wider world) cannot afford to rely exclusively on one, or even two, non-Community systems under military control for the establishment of standards in areas which are of such crucial importance and where the introduction of advanced safety features on a coordinated scale is required.

The number of consumers of services generated in this sector is increasing day by day in all areas of activity (management of moving bodies, positioning of objects, insurance, geodesy, etc.). Day by day turnovers are growing, thereby placing our economies more and more at the mercy of these positioning and speed measurement systems based on satellite radio navigation. Leaving aside the need to ensure a technical abundance of signals compatible with the high-precision applications affecting, in particular, the safety of human lives, can we really afford to be dependent on just one non-European signal in order to safeguard these turnovers and the jobs that will depend thereon?

Galileo will open up possibilities for developing applications, many of them hitherto undreamed of, which will help in the performance of public service tasks in a very wide variety of areas (customs and excise, transport, policing operations, searches for missing persons, the pursuit of offenders, judicial enquiries, humanitarian operations, etc.).

As part of a new Community approach adapted to a new century, the most obvious user of a precise positioning and speed calculation signal, viz. the transport sector, will be one of Galileo's key customers**:**

- Airspace and airports are becoming increasingly congested. More effective management structures are gradually being put in place, but it is clear that this will not be enough. The report of the High Level Group on a Single European Sky emphasises the importance of introducing new technologies as a way of boosting capacity. While satellite radio navigation is a key element, it will also be necessary for safety reasons to ensure an abundance of systems (given that mere reliance on a foreign military system is out of the question) as well as ensuring integrity, i.e. a knowledge of the quality of the signal used.

- Tighter controls are also needed in the development of sea transport. The Commission has presented proposals for Directives[5] in this respect. Recent disasters such as the sinking of the Erika oil tanker and the Ievoli Sun chemical tanker demonstrate the need for a certified position report that only Galileo[6] can provide, in support of the new regulations on maritime safety.

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[5] COM(2000)142.final, 21.3.00

[6] Other satellite navigation systems will also be capable of providing this service to the extent that it is certified and guaranteed by the service operator

- Inland transport, the principal mode of transport for goods and persons in our modern economies, also needs to undergo reforms. According to the Commission's White Paper on the Common Transport Policy[7], no infrastructure will be capable of managing its own growth unaided. An appropriate measure might be the imposition of an automatic, certified reporting and registration obligation with regard to position and speed. Across the entire territory of the European Union, only Galileo[6] will have the capabilities needed to enable the authorities not only to identify traffic flows more effectively and hence manage them more efficiently but also to reorganise the economy in the transport sector.

- The urgent need to speed up significantly policing, judicial and insurance dispute procedures (with a resulting reduction in the cost of premiums) or commercial disputes associated with transport (thefts, accidents, delivery delays, etc.) will mean that very soon an active or passive position notification system, albeit of course certified and guaranteed, will become an essential prerequisite. Once again, only Galileo will be capable of providing the market with such a system. The same certified and guaranteed system will enable users to pass by motorway, urban or other tollbooths automatically, and without stopping.

Leaving aside dating and transport, Europe also needs to be wholly involved in the satellite navigation revolution. Recent GSM and UMTS[8] developments in Europe (the two generations of portable telephone which will eventually include the Galileo signal), and before that developments involving Ariane and the Airbus, have clearly demonstrated the positive impact that a determined, politically inspired and sectoral approach to modernisation will have on employment, on industrial and economic development and on the enhancement of the international influence of the European Union.

The whole range of positioning applications (whether certified or not) will bring in their wake a plethora of new services to be developed by a very large number of companies. The Galileo receivers, which will also be capable of receiving Russian (Glonass) and American (GPS) signals, will need to be able to penetrate those markets. The GPS, under pressure from users and with the prospect of Galileo's arrival on the scene, has benefited from the cessation (overnight, as it were) of selective degradation[9] in May 2000. It is difficult to accept that our receiver manufacturers and their users should be obliged to adapt, without prior warning, to the vagaries of a signal decided on elsewhere.

Lastly, a further challenge inherent in this project is the mobilisation of the private sector. This communication demonstrates that - apart from the socio-economic benefits which are enough in themselves to justify the public funding of the entire project - there are sufficient opportunities for generating economic returns from the development of Galileo to interest industrialists and bankers.

Many other investors, be they companies interested in supplying components, satellites and ground equipment, or, more importantly, large, medium or small enterprises specialising in the provision of services, have confirmed that they will participate in Galileo once the following two conditions have been met**:**

- the necessary political and financial decisions on the launching of the development and validation phase have been taken;

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7 COM(2000)…. final, ...

8 3rd generation of mobile telephony allowing the use of very high-speed Internet capabilities

9 Degradation of signal accuracy, limiting civil use

- a single entity, operating within a precise institutional framework, has been appointed to manage the various aspects of the programme.

Part 1: Definition of the system

The aim of this chapter is to present the Galileo system based on the overall picture that has emerged in the course of the studies conducted during the definition phase. The presentation takes as its point of departure the needs expressed by the potential users and goes on to describe the services needed to meet those requirements. The next part seeks to describe the architecture of the system, designed in such a way as to be capable of providing these services. Subsequent chapters tackle related matters pertaining to Egnos[10] *and to certification and international aspects which have been, and will have to be, taken into account during the programme development and validation phase.*

1. Users' needs and the services offered by Galileo

A. Users' needs

The approach to setting up a navigation infrastructure is based on the requirements expressed by the potential users of the services offered, from the end user to the service providers (important stakeholders in the value-added chain) and including the public authorities responsible for implementing a wide variety of rules and regulations.

During the Galileo programme definition phase, consistent work has been carried out involving consultations with a broad range of users covering a significant number of areas. Various forums have been held in several areas of application such as aviation, the railways, the maritime sector, road-linked applications, applications involving the general public, scientific applications and time-distribution applications.

For each forum, 50 or so of the most representative persons in their field, spread fairly among the European countries involved in the Galileo programme[11], were contacted and their help enlisted in drawing up the specifications for the positioning, navigation, time and search and rescue services.

As a result of these large-scale consultations, there is now a clear realisation of the need for a global service, that is to say a service that covers the entire globe including the oceans and desert areas, with a view not only to ensuring the continuity of services involving maritime and aviation applications[12] but also to enabling the equipment manufacturers (notably the receiving equipment manufacturers) to achieve economies of scale in an unsegmented market. The majority of the public and private players involved in these consultations also stressed the fundamental need for channels of communication: only through the achievement of perfect synergy between the positioning, navigation and dating services, on the one hand, and the communication services, on the other, is there any likelihood that the services on offer[13] can

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[10] Egnos, the European precursor of Galileo, is a satellite radio navigation system that relies on the American GPS and the Russian Glonass systems and ensures their integrity, i.e. it warns the user over a very short timespan of any malfunction that might affect the quality of the signal retransmitted by geostationary satellites

[11] Also including the member countries of the European Space Agency which are not Member States of the European Union as well as countries applying to join the European Union

[12] In addition, this global cover will enable Galileo's services to be supplied to the non-European territories of Member States of the European Union or of the European Space Agency in other regions of the world

[13] At user level, the technical choices for implementing these channels of communication are immaterial

be exploited to the full. Consequently, the concept of a "panoply" of services will need to be fully incorporated into the parameters of the navigation system.

Such a service is provided for in the basic solution presented in this communication through the establishment of certifiable interconnections between Galileo and communication networks located on the ground or installed in existing satellites. A technical alternative is being studied as an option that could be exercised as early as the first half of 2001 and which would involve launching a communications payload on the satellites. This possibility will be adopted only if it entails no appreciable cost implications for the public investor.[14]

Involving communications facilities will also necessitate an in-depth examination of the regulatory aspects and, in particular, of the licensing and interconnection arrangements in the internal market for electronic communications networks and services.

Applications will be forthcoming to improve mapping in Europe and beyond, particularly in developing countries with which the Community has special relations. Applications focusing on earth observation will also be studied as part of a global and sustainable development strategy.

Galileo includes a set of equipment designed to provide a modern search and rescue service[15]. The signatory states to the International COSPAS-SARSAT[16] Convention, which are currently implementing the only system of this kind covering the entire globe, have been contacted and have openly expressed interest in a new service to be provided by Galileo. The United States, for its part, is examining the possibility of setting up a similar and potentially complementary system on future generations of the GPS. Apart from the number of lives saved, this service is obviously of interest on a geopolitical and planetary scale.

On the basis of the accompanying analysis of the present and future needs of users and of the markets associated with the underlying applications, it has been possible to identify a set of forecasts (number of users per field of application) used in the cost-benefit analysis.

Lastly, several parameters describing the different levels of service required for each type of application have emerged from the analyses described above. The principal parameters concern a global need for a degree of accuracy that is at least as good as that provided by the GPS, for integrity[17] in certain specific areas - mainly those where human life is at stake[18] - and for the availability of an improved service, both in urban (local) areas and in the Nordic regions.

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14 This assessment will need to include the possible legal, and hence financial, risks that such a solution could entail, having regard to the commitments entered into in the framework of the World Trade Organisation and given that the telecommunications sector is covered by the General Agreement on Trade in Services (GATS, 1994).

15 See Annex 3

16 France, Canada, the United States and the Russian Federation

17 Information on the integrity of the system is relayed to the user by means of an indicator providing him with information, virtually in real time, on the quality of the signals transmitted and on any malfunction detected

18 The demand for integrity in the range of services offered is expected to become the general norm in a growing number of applications

B. The services offered by Galileo and their applications

On the basis of the consultations conducted with the users, three categories of services have been defined to meet their needs.

1). The general service

This will involve the provision of a positioning, navigation and dating service compatible with the existing services but offering a greater degree of accuracy. It will be available for use by any person in possession of a Galileo receiver receiving all the existing signals. No authorisation will be required to access this service.

The principal applications will be private road navigation, network dating, traffic information systems and systems providing information on alternative routes in the event of congestion, mobile telephony, etc. Numerous types of receiver will be developed at widely varying prices, depending on the applications proposed.

In principle, there will be no charge for using this signal, although a quality certificate regime (see Chapter 4, Part 2) may be envisaged for high-quality, expensive receivers.

2). The commercial service

Service providers using this service to give added value to their range of products will pay a fee to the Galileo operator. The signal will contain data relating to the additional commercial services being offered. In return for the fee, the Galileo operator will be able to offer certain service guarantees.

The main applications will concern professional users who are ready to pay for a service guaranteed by the Galileo operator, notably in the areas of geodesy and in activities involving customs and excise operations, network synchronisation, sea fleet management, vehicle fleet management, road tolls, etc.

There will be controlled access to this service for end-users and the providers of value-added services. This controlled access will be based on protected access keys (along the lines of the PIN code for GSMs) in the receivers. Such a solution, yet to be confirmed by the service providers, will avoid the need for the more onerous technique of signal encryption, although the latter will still come under scrutiny during the validation phase. In fact, controlled access will enable revenue to be collected from users who are subscribers.

3). The public service

This service will be offered to users who are highly dependent on precision, signal quality and signal transmission reliability. It will need to offer a very high level[19] of integrity and, consequently, to provide the user with a very rapid warning of any possible malfunctions. It will need to be certified in accordance with the regulations applicable to the various modes of transport (the ICAO regulations in the case of air transport, the IMO regulations in the case of sea transport, as well as any future European regulations relating to the Common Transport Policy). This service will require specialised receivers providing access to this enhanced-quality signal. Depending on the decisions taken by the European or international standards organisations, this service may be restricted to authorised users. Because of security requirements, it will not be possible for all of the signals intended for this service to be provided on the same frequency.

Of particular concern are applications intended for air and sea navigation, the management and regulation of road and rail traffic, the emergency services, road tolls, controlled access to towns and cities, transport of dangerous substances, carriage and monitoring of dangerous persons, humanitarian operations and, lastly, the registration of black boxes.

The relevant revenues will be generated by providing controlled access to the signal for such users as air traffic controllers, air companies, public network managers, rail companies, road traffic controllers, the customs and excise authorities, etc. For services with high-level security requirements, a signal encryption option has been included in the financial estimates, and a decision on whether or not to exercise this option will be taken during the validation phase.

In addition, a specific public service designed to assist in search and rescue[20] operations will make it possible to locate persons and vehicles in distress. The vehicles will be fitted with beacons which, having been activated in the event of an emergency, will send an alerting signal to a rescue centre. An acknowledgement that the signal has been received and logged will immediately be sent back to the stranded person.

Furthermore, the use of one of the three services described above in conjunction with a telecommunications service, e.g. GSM or UMTS, will enable positioning data to be supplied or distributed in a much more user-friendly fashion, where necessary combined with other information such as a road map, the distance to be covered, the pinpointing of traffic congestion and information on alternative routes. It will also enable payments to be made for tolls of all kinds.

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19 No satellite radio navigation system of this quality, combining universality, accuracy, certification and guarantees, exists at present

20 A working party has been set up to incorporate this service within COSPAS-SARSAT (see page 9), which at present does not send back this crucial signal in order to keep up the morale of the victims nor does it guarantee that the alert will be sounded instantaneously. The service will be free but will require a licence for the purchase of the beacon

2. <u>System architecture</u>

The Galileo system architecture must be designed in such a way as to permit:

- *adaptation* of the response to the needs of users and to market trends;
- *integration* of services other than navigation;
- *minimisation* of development and operating costs;
- *minimisation* of the risks, other than financial risks, inherent in a project so unusual by virtue of its scope, complexity and the challenges it poses;[21]
- *interoperability* with existing systems, notably GPS, while at the same time maintaining autonomy and competitiveness.

1. The main foundations of the Galileo system

The concept is global, that is to say it is based on the distribution of signals over the entire surface of the globe, offering three major categories of navigation services:

- a general service;
- a commercial service;
- a public service.

With the exception of the general service, all the Galileo services provide system integrity[22] information. The architecture is such as to enable other regions (groups of countries that may have entered into partnership agreements with Galileo) to personalise the system integrity information at a regional level.

With a view to facilitating interoperability at the user sector level and to promoting the penetration of certain markets, it is also planned to disseminate integrity information relating to the GPS satellite and, where appropriate, the Glonass satellite in addition to the integrity information on the Galileo satellites.

Lastly, the need for information exchange or the onward transmission of the position of Galileo users will result in the incorporation of the low-volume communications services in addition to the navigation information. These services will rely on the existing terrestrial or space infrastructure.

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[21] These risks may be political or international in character, due mainly to the dual nature of the technologies employed (some of Galileo's equipment or components will be subject to the existing rules governing the sector so as not to compromise the commitments and objectives of the European Union in the field of non-proliferation), or the risks may be legal in character by virtue of certain international conventions and obligations (cf. law of outer space, international regulations governing air and sea navigation, WTO, etc.).

[22] Information on the integrity of the system is relayed to the user by means of an indicator providing him with information, virtually in real time, on the quality of the signals transmitted and on any malfunction detected

The Galileo signals

The definition and optimisation of the services are wholly dependent on the characteristics of the signal transmitted from the satellites and from the local ground components as well as on the constraints affecting the use of the electromagnetic frequency spectrum. A twofold approach is being adopted with regard to the Galileo signal frequencies:

– The basic solution set out in this communication relies on the frequency bands newly allocated to Galileo following the World Radiocommunication Conference (WRC2000), which offers Europe real technical opportunities in defining the signal, although certain technical conditions still need to be verified; the preparation of the next WRC, planned for 2003, forms part of the validation phase activities.

– Two further options, based on the sharing and partial recovery of the frequency bands allocated to the existing systems (the American GPS and the Russian Glonass), are currently being studied with a view to ensuring optimisation of the use of frequencies and of the performance offered, while at the same time reinforcing interoperability, and hence robustness, without having a significant impact on the total cost of the system.

The final choice of signal characteristics will be made on the basis of the best technical solutions[23] to emerge from a pooling of the results of the international negotiations. At all events, a choice will be made in the first half of 2001 during the validation phase.

The security constraints

Given that the use of Galileo by malevolent forces could pose a danger to European interests, provision must be made for preventive action and countermeasures (withholding of the service, controls on the export of certain sensitive components). These constraints will take the form of measures to ensure the physical protection of the system and to control access to certain services. In addition, Galileo will need to be protected against any external or hostile intrusion into the system aimed at modifying by whatever means (physically or electronically) the system itself or the services which it provides.

Consequently, in the event of a crisis, a European political body independent of Galileo management structures - to be defined under the CFSP - will need to be empowered to take the necessary measures. In addition, operational procedures will need to be put in place, under

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[23] The definition studies carried out over a 12-month period reveal that:
- Band C (5010 – 5030 MHz) offers certain attractions for new services to be envisaged in the future, notably because it is more resistant to interference; consequently, an experimental payload will be installed during the validation phase with a view to taking a decision on the gradual introduction of this option in future generations of the Galileo system; funding is provided for under the associated technological programme;
- all the proposed services require, as a minimum, the simultaneous use of 2 frequencies, in this instance in Band L, with an adequate frequency separation (Bands L1, and L2) (1164 – 1300 MHz; 15590 – 1610 MHz);
- given the personal safety implications of the public service (aviation being a typical example) and the need for it to be protected against all forms of interference from other systems, this service will use the band reserved for aeronautical applications (ARNSS - Aeronautical Radio Navigation Satellite-Based Services);
- the requirements associated with the protection of such services as the service needed to implement the Common Transport Policy will probably necessitate the segregation of the relevant frequency spectrum

the CFSP, between the body eventually designated and the Galileo management structure in order to manage possible crisis situations.

Data protection – and, in particular, the protection of private data – will be assured under existing legislation.

2. The principal components of the architecture[24]

The Galileo architecture is made up of four principal components:

- the global-coverage space component;
- the regional components;;
- the local components;
- the user receivers and terminals.

a) The global-coverage space component consists of the space sector, in this instance a constellation of 30 medium earth orbit[25] satellites, and the associated ground control sector.

Before settling on this choice, several types of constellations[26] were studied using different criteria. In particular, these studies show that the recommended architecture based exclusively on satellites in orbit, and the architecture recommended here, ensures more uniform performance both in terms of accuracy and availability and offers greater robustness in crippled mode (satellite failure), particularly in the case of high latitude countries or in towns and cities, while at the same time being less onerous .

The size and mass of the satellites under consideration for this type of mission should ensure optimum deployment of the constellation through multiple launchings (5 to 6 satellites per launcher).

The ultimate choice of launcher(s) will be made on a competitive basis and will depend on the payload capability (number of satellites) for the period in question, on reliability factors, proposed costs and contractual conditions (insurance).

The ground segment[27] consists of the satellite control centres (telemetering and telecommand stations to keep the satellites on station) and the centres needed to provide the services.

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24 See development plan in point 4

25 The MEO (medium earth orbit) satellites are evenly distributed over 3 orbital planes at an altitude of about 23 000 km

26 As mentioned in the communication of 10 February 1999, various types of orbit were considered for the constellations: LEO (low earth orbit), MEO (medium earth orbit), GEO (geostationary earth orbit), IGSO (inclined geosynchronous orbit). During the definition phase, several studies focused on constellations based solely on MEOs (10 to 33 satellites at different inclinations) and on a combination of MEOs (18 to 27) and GEOs (8 to 9). Lastly, two types of architecture were subjected to more detailed comparisons: 30 MEOs on 3 planes and 24 MEOs and 8 GEOs, all in the light of different criteria (performance attained, geographical uniformity, risks and costs, management constraints). The best performance is provided by the 30 MEO architecture, particularly at high latitudes and for a significantly lower cost

27 The terrestrial segment whereby the service is provided consists mainly of:
- the integrity control stations;
- the interfaces with other systems (COSPAS-SARSAT, Universal Time);

b) <u>The regional components</u>

The system is global and integrity is spread world-wide. However, the design of the system is such as to permit the introduction of regional components (up a maximum of 8 all over the world), thereby making it possible to "personalise" integrity under partnership agreements with the relevant countries. The cost of this component will be borne by the region in question.

A regional component is made up of an additional network of stations to oversee the integrity of the signals and a processing centre to provide this service.

c. <u>The local components</u>

The Galileo system will provide a high level of performance to users world-wide, even in places where there is no ground infrastructure. However, in the case of specific applications in given areas, even more demanding levels of positioning performance will be necessary or, alternatively, integration with other functions, e.g. local communications, will confer added value on the basic service.

In this way, starting from a common generic conception, it will be possible to adapt local elements to specific requirements:[28] airports, ports, rail, roads, urban areas, etc. Furthermore, each application will need to make provision for specific cases: road tunnels, urban buildings, underground parking complexes, etc. The definition phase has enabled a preliminary conception to be formed of these local elements, and this will be elaborated further during the development and validation phase.

Typically, a local element will need to ensure the onward transmission of the signal, including integrity monitoring and data processing and transmission.

Data may be transmitted to the user's receiver either via a specific link or by means of external systems: mobile communication networks (using GSM or UMTS standards), Loran-C maritime navigation system, etc. In the last mentioned instance, detailed information on the user's exact position will also be available to the operator. By means of messages linking the Terminal and the Service Centre it will be possible to confer added value on the basic service, e.g. pinpointing the location of distress calls or breakdowns. This, in turn, will cause thought to be given to the introduction of possible changes to the existing standards, with a view to incorporating the capabilities offered by Galileo.

For certain modes of transport such as aviation, the existence of a local component offering a landing service adapted to the meteorological conditions prevailing in Europe will play a key role in rationalising the existing structures and making satellite navigation more attractive economically. For this reason, the Commission is committed to promoting the necessary technical and economic studies and, if the scheme is clearly feasible, it will facilitate the organisation of a local service through the structures put in place.

- the communication networks between the various terrestrial segment components;
- the navigation mission control centres

[28] In general, these specific requirements will focus on the need for a high degree of accuracy (down to less than a metre) and the need for local integrity information to trigger an alarm in a very short space of time (e.g. less than a second in the case of civil aviation) or to facilitate the continuity of the service in an urban environment when satellite visibility is reduced or down to zero

3. The Galileo receivers

These receivers will be the crucial link in the Galileo chain and will need to satisfy market requirements:

- competitive performance and costs compared with the existing systems;
- adequate tailoring to the needs of users (general public and the professional market);
- potential for change and integration of the services (e.g. communications);
- possibility of multi-modal use;

A wide range of Galileo receivers will be available providing the various types of satellite radio navigation services on offer, whether or not combined with other functions. In addition, the technological potential will lead to a high degree of integration of these functions (standard "microchips" tailored to a specific function). By way of illustration the following examples may be cited:

- Galileo mini-terminals for use by the general public, or the incorporation of a positioning function as an integral feature in mobile telephones (UMTS standard), providing value-added services or position location facilities in the event of “112” calls (emergency services);
- the integration of a navigation service certified under aircraft industry standards in the operational support system for aircraft pilots;
- an in-vehicle navigation platform offering the driver combined positioning and traffic information monitoring facilities.

The challenge of the market in Galileo receivers represents one of the major factors that will determine whether the European industry successfully takes off in this area.

4. The Galileo development plan[29]

Under the arrangements to extend the definition phase which is due to conclude at the end of 2000, the Galileo development plan will be divided into two main phases:

<u>A development and validation phase </u>(2001–2005)

The development and validation phase, due to commence in 2001, will cover the detailed definition and subsequent manufacture of the various system components: satellites, ground components, user receivers.

This validation will require the putting into orbit of prototype satellites from 2004 and the creation of a minimal terrestrial infrastructure. It will allow the necessary adjustments to be made to the ground sector with a view to its global deployment and the launching, if necessary, of operational prototypes manufactured in parallel. During this phase it will also be possible to develop the receivers and local elements and to verify the frequency allocation conditions imposed by the International Telecommunication Union.

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[29] See diagram in Annex 5

A constellation deployment phase (2006–2007)

This deployment phase will consist in gradually putting all the operational satellites into orbit from 2006[30] and in ensuring the full deployment of the ground infrastructure so as to be able to offer an operational service from 2008 onwards.

During the system validation phase, as described above, the risks inherent in the programme will be reduced by a programme of technological support to help finalise the critical choices, both technical and technological (atomic clocks, receivers, use of Band C, telecommunications payload, intersatellite links, etc.). It is important to consider these activities so as to ensure that the second-generation Galileo system remains adapted to the changing needs of users.

Consequently, users will have an operational Egnos service at their disposal from 2003 (see Chapter I.3) and will witness the gradual introduction of an operational Galileo service by the beginning of 2008[31] at the latest, with the Egnos services being provided in parallel until they are phased out altogether.

3. The integration of Egnos into Galileo

Egnos, the European precursor to Galileo, is a satellite radio navigation system that relies on the American GPS and the Russian Glonass and monitors their integrity, thereby warning the user in a very short space of time of any malfunction that could affect the quality of the signal relayed by geostationary satellites.[32]

Annex 5 describes the characteristics and benefits of Egnos, its potential for mobilising European expertise in engineering, manufacturing and the provision of services in the field of space applications and, lastly, the process whereby it will be gradually integrated into the architecture and structures of Galileo, eventually disappearing from the scene by about 2015.

4. Regulation, standardisation and certification

Galileo will make an essential contribution to the good management and safety of all modes of transport. It will enhance the quality of existing systems by virtue of its being managed by civilians and by virtue of its global coverage, precision, integrity and the guarantees it will offer.

The provision of these features will require a system for regulating the activities in question through the imposition of standards to be complied with and the monitoring of such compliance by the competent Community bodies.

Regulation and certification will require Community legislation. In developing and implementing such a regulation and certification system, the Commission will enlist the aid of the existing public structure, to which certain activities could be delegated.

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[30] In order to ensure adherence to this timetable, satellite production should commence no later than 2004

[31] Access to the market would require a more concise development plan, and a number of approaches are being examined: e.g. provision of a commercial service for the general public in advance of the other technically more exacting services. However, given the risks currently being assessed (availability of clocks, etc.), it would be premature to commit oneself to such a timetable. Nevertheless, once the initial technical tests have been carried out, work can begin on the campaigns to promote the Galileo satellite applications and to verify the regulatory uses, probably starting in 2006

[32] In circular orbit 36 000 km above the terrestrial equator

Given that Galileo will be providing services on an international scale, the European Union, in cooperation with the European certification bodies, will need to define the positions to be defended by the Member States within the framework of international organisations such as the ICAO and the IMO.

5. International cooperation

International cooperation is essential to a project of such international potential as Galileo. It is equally essential in terms of ensuring interoperability with existing systems, of involving third country markets and, lastly, of installing the ground sector components in certain parts of the globe. A Committee, made up of representatives of the Member States, will be responsible for assisting the Commission in the negotiations / discussions with third countries.

In accordance with the mandate which it was given by the Council in October 1999, the Commission has embarked on formal negotiations to identify potential areas of cooperation with the countries that own the existing systems, viz. the United States and the Russian Federation, and, in a wider perspective, with third countries having an interest in the development of Galileo.

The results of the World Radiocommunication Conference held in Istanbul in May 2000 have demonstrated not only the strong support for Galileo on the part of many countries across five continents but also the need to coordinate access to new frequencies allocated to radio navigation under International Telecommunication Union rules.

1. The negotiations with the **United States** have helped to clarify a number of the points that have to be dealt with.

Initially, the European Union and the United States have discussed and documented their ideas on the spectrum, the signal, the security of the systems, standardisation and interoperability requirements. Both parties are agreed that the principal objective is to ensure compatibility and interoperability between Galileo and the GPS.

The European Union has, on a number of occasions, voiced its determination to forge ahead rapidly with the technical discussions. As far as the present American delegation is concerned, the top priority is probably the Council Decision of December, followed by the preparation of a framework agreement on the principles signed up to at high level, which would serve as a basis for all subsequent technical work.

Nevertheless, the Commission intends to pursue contacts at all levels so as to be in a position to consolidate the definition of the interoperability and frequency sharing options with the GPS before the middle of 2001 and to reconcile international technical positions as within the ICAO, IMO or COSPAS-SARSAT.

2. Negotiations with the **Russian Federation** are taking place at political and technical levels. They are based on a cooperation scenario aimed at promoting the coexistence of two independent constellations (Glonass and Galileo), while at the same time seeking to achieve possible reductions in investment costs. They are based on the principles associated, on the one hand, with an exchange between interoperability and frequency sharing and, on the other, with industrial cooperation.

Four significant industrial cooperation projects, financed by the European Space Agency, the Commission and certain Member States, have started up under the supervision of the special negotiation Committee set up by the Council to assist the Commission.

Initial discussions on a possible framework agreement with Russia and spectrum sharing are making good progress. It is proposed to draw up an initial balance-sheet by the end of 2000.

At the last EU/Russia Summit on 30 October 2000, the Joint Declaration mentions that: *The sides recognise the importance they attach to pursuing the cooperation initiated between the Russian and European satellite navigation systems (Glonass/Galileo).*

3. The Commission is eager to involve other partners in Galileo at an early stage. At the Council's request it has identified and verified the interest expressed by a number of countries in participating in Galileo, notably on the occasion of the World Radiocommunication Conference referred to above.

Moreover, the configuration of the system will be such as to confer a high regional profile on the integrity information, thereby proving particularly attractive to third country groupings.

Such participation could take place at two levels: at the level of the direct investment and industrial work necessary in the development and operational fields, or at the level of user applications and equipment.

In Europe, the participation of Switzerland and the **EFTA** (European Free Trade Area) countries is assured, and discussions are currently under way with **Central and East European countries** and **Ukraine**.

Canada is involved financially in the Galileo definition studies. This promising cooperation will help to develop the regional element across the American continent - an indispensable requirement if regional signal quality control is to be guaranteed. In accordance with the Council Resolution, the Commission is likely in the near future to present a draft mandate for formal negotiations with Canada.

Contacts with a number of **Latin-American countries** will need to be renewed and intensified in 2001 so as to enable Egnos to be validated in real time. Exploratory contacts have been initiated with **Australia**.

Israel and a number of **African countries** (South Africa, Kenya, Egypt, etc.) as well as several **Asian countries** (China, Korea, India, etc.) expressed a keen interest at the Telecommunications Conference and in the course of bilateral meetings.

A particular effort will be made to examine the possible uses of Galileo and their specific nature and economic potential in developing countries in the context of Community agreements like the one concluded with ACP countries.

Part 2: Economic and financial aspects

The first chapter incorporates a table setting out (a) the cost of the various phases of the programme (see summary table below) and of the management of the operating system and (b) the socio-economic benefits for society in general when it becomes operational, and the more immediate financial advantages - in terms of service supply and equipment sales.

The second part describes the funding schedule for the various stages of the programme by listing both the public and private-sector contributions. Here the Commission stresses that, in view of the expected turnover figures, the private sector could contribute €1.5 billion to the funding of the deployment phase.

The final part describes various sources of revenue, and more particularly a special tax when Galileo becomes operative.

The successive stages of the Galileo Programme

Development and validation phase (2001-2005)

Detailed definition of the sectors as a whole (space, ground-based, users);

– development of satellites, ground-based components;

– "in-orbit" validation of the system.

Deployment phase (2006-2007)

– satellite assembly and launching;

– installation of complete ground-based component;

Operating phase (from 2008)

– satellite renewal, operation of the Centres, maintenance.

1. The cost of Galileo

The cost estimate covers a Galileo system able to offer the various general, commercial and public-interest services described in Chapter I.1. The cost covers the entire development, validation and deployment phases of the complete constellation enabling an operational service to be supplied to customers. Basically this involves:

– detailed definition studies preceding the production of the spatial, ground-based and user components;

– assembly of the satellites, including prototypes and then production models, and the associated testing equipment;

– assembling ground-based components, deploying these and the relevant testing;

– satellite launching and their in-orbit validation;

These costs are summarised in the table below, which sets out the main items and draws a distinction between the development and validation phase and that of deployment of the various planned installations.

Certain hypotheses or details are worthy of mention:

– the deployment of local components, including those in Europe, is not included[33]; conversely the definition and generic design part is included;

– a "search and rescue" service on board Galileo is included;

– the deployment of the ground-based stations needed in order to introduce an optional regional (specificity) for integrity (outside Europe) is not included (conversely definition and generic design are included); the States concerned will bear the cost of any such deployment;

– the cost of incorporating Egnos into Galileo will be taken into account via the approach described in Annex 5 (Egnos' initial operating phase between 2004 and 2008 is not included and booked as being borne by its operator);

– the technological-support activities and the initial studies for the next generation of Galileo are included;

– the launch cost is an average price for the commercial launchers in the Ariane 5, Proton range on the basis of a multiple launch; if a launch fails the cost of the relaunch, but not replacement of the satellite, is included in the estimate given);

– the costs of security aspects are estimated on the basis of sensitive civilian infrastructures;

– the Galileo-certification aspects are based on the Egnos precedent;

– the cost of developing a basic receiver for each service is taken into account in the estimate but not its tailoring to the wide range of applications.

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33 The cost of local factors is highly variable depending on the applications under consideration (by way of illustration and per installation: from €100 000 for general-public needs to €1 million for aviation needs). The short duration of their assembly (three months - one year) will permit adaptation to a European development plan which remains to be drawn up in the light of the applications. Indeed, these ground-based components, which directly relay the signal in inaccessible spots (5% of Galileo cover) are especially necessary for the services to be licensed. The market will determine demand for these, their location and funding. The generic design and definition of these components form part of the development and validation stage and are included in the estimate

Cost in millions of euros (2000 price estimate)	Development Validation	Deployment
Management, engineering, systems design	160	130
Satellites	240	660
Launches	80	660
Ground-based component Global and regional Local	480	380
Operations	70	210
Technological-design support programme	70	60
Galileo illustrative estimate	**1100**[34]	**2100**
Incorporating Egnos	-	50
Total cost	**3250**	

Activities outside the development and deployment of the system as such, as will be necessary to ensure the emergence of the markets identified, are set out in the table below. The funding shown is a minimum expenditure threshold to ensure economic viability of the programme as a whole. Other funding (private sector) is expected to come from the public-private partnership context.

- Development of applications - Support for user sector - Standardisation measures - Support for the deployment of local components	€150 million

The annual cost of operating Galileo, including constellation replacement, is estimated to be €220 million per year, €70 million of which are operating and maintenance costs. The annual operating cost for Egnos is €25 million per year between 2003 and 2007.

	Egnos 2003 – 2007	Galileo 2008
Annual operating cost in millions of euros	**25**	**220**

34 This does not include support for the deployment of local components or for the development of applications and receivers which do not form part of the architecture as such.

Cost of Galileo Programme (per phase) including Egnos (in millions of euros):

definition (1999-2000): 80
development and validation (2001-2005): 1.100
deployment (2006-2007): 2.150
operating (2008-): 220 per year

2. Galileo funding

1. The development and validation phase (2001 – 2005)

According to the financial estimates the cost during that period will be roughly €1.1 billion.

That amount will be provided entirely by public funding (Community budget and that of the European Space Agency).

Community funding

The Community nature of the programme and its being a crucial feature of the common transport policy and the "trans-European transport networks" initiative did, in essence, justify the European Community's role in both political and financial terms during the definition phase.

The same applies to the subsequent phases of the programme and, as stated in the Commission's communication of February 1999, the European-Union budget assigned to Galileo will receive funds already earmarked in the existing financial forecasts (essentially the trans-European networks and the 5th framework research programme and possibly future research actions which are subject to decisions of the Council and the European Parliament.

As part of the **trans-European networks** programme, the introducing of Galileo into the MIP (Multiannual Illustrative Programme) was put to the Committee on trans-European transport networks by the Commission in September 2000. The latter proved this in principle in accordance with the Council and European Parliament Decision of 19 July 1999. The amount corresponding to the activities under the Galileo Programme for the years ahead is roughly **€550 million**. Under budget heading B5-700 this enables 50% of the cost of the design stage, including technical support, to be covered.

The 5th **framework research programme** will continue to set aside top-up funds for the Galileo Programme's development and validation stage. Any contribution from future research actions is subject to its being adopted by the Council and the European Parliament. These funds (5th framework programme and future research actions) will cover support for the development of applications and receivers not forming part of the architecture as such, but whose specification will be necessary when private partners or an operator are to be identified.

The level of Community funding is critical since it will determine whether political control can be maintained of the following phase of the programme. It will also help to guard against any drawback resulting from the rules of geographic return provided for by the Convention establishing the European Space Agency.

The European Space Agency's contribution

The European Space Agency has confirmed that it had long ago used its institutional machinery to make plans for asking the Member States to subscribe **€550 million**[35] for the validation phase if the political decision to continue with the programme were taken by the transport Council on 20 December.

In short the cost of the development and validation phase amounts to €1.1 billion for infrastructure and €150 million for the deployment of local components and the development of applications and receivers.

All of the needs for the development and validation of the infrastructure have already been covered by European public funding (European Union and European Space Agency) that has already been scheduled. No further public contribution by the Member States will therefore be needed.

2. The deployment phase (2006-2007)

Beyond the current financial outlook the origin and amount of the Community's contribution and that of the European Space Agency still need to be determined during the validation phase.

During that phase the estimated costs are **€2.1 billion** of which €1.5 billion can justifiably be borne by the private sector and €0.6 billion borne by the public sector.

Other sources of funding can likewise be mobilised by the machinery used to award licences for service suppliers or operators (calls for tender, bids, etc.) for example for the commercial operation of the Galileo signal associated with local factors.

The table below sets out the private and public contributions to the three phases and, as regards the latter's contributions, a breakdown between those made by the European Union and those by the European Space Agency:

[35] That request was based on the European Space Agency's programme Declaration in 1999 estimating the development and validation phase at €1 000 million

Sources of funding	Million Definition phase	Million Development and validation phase	Million Deployment phase (estimated)
European Space Agency[36]	**40**	**550**	**600** (EU[38] and European Space Agency)
European Union *of which:* *Trans-European transport networks* *5th Framework research programme* *Future research actions*	**42.5**	**580 + pm** *550* *30* *pm*[37]	
Private sector	**0**	**0**	**1 500**
TOTAL	**82.5**	**1 130 + pm**	**2 100**

3. The operational phase (from 2008)

As soon as possible during the validation phase the Commission intends to propose that a fund be set up to receive the public contributions while being open to private investment and, where appropriate, an input from non-member states. This fund should give it legal personality and funding rules that are suitable for approval by the contributing parties.

No funding in the form of subsidies will be necessary downstream of the deployment phase. Indeed, this could take place within the public - private partnership (see following section) and via the new revenue flows described in Chapter 4 below.

4. The public - private partnership

This will be an essential factor for the success of the Galileo Programme. It will be built up through an interim management structure responsible for the legal and financial package, from the development and validation phase onwards in order to involve the private sector in carrying out the programme as quickly as possible.

It should again be borne in mind, on a preliminary basis, that the cost incurred during the deployment stage is estimated to be €2.1 billion of which €1.5 billion are estimated as able to be borne by the private sector[39] and €0.6 billion by the public sector.

In order to meet a request made by the Council on 17 July 1999, which called for substantial funding from the private sector in Galileo, the Commission issued a call for an expression of interest in order to establish the conditions needed in order to set up a public-private partnership. Several European industrial consortia responded to this.

36 The funds needed for the following two phases will be mobilised subject to approval by the Member States of the European Space Agency.

37 The references to future research actions in no way prejudice the political decision of the European Parliament and the Council as to those actions' priorities, resources and management.

38 The contribution of the Community budget to the funding of Galileo for 2007 will be examined as part of the process of preparing financial forecasts relating to the period after 2006.

39 See Section 3 B: the financial benefits deriving from Galileo

It emerges from the analyses carried out with the latter and from identifying the turnover figures expected from Galileo operation, that involvement by private investors in the programme is a thoroughly likely prospect in line with the estimated funding for the deployment of the system, the local factors and the subsequent development of receivers and services. However, there are a certain number of prerequisites:

The political decision to continue the programme in December 2000[40]; all insisted on an urgent decision on that date.

The essential requirements regarding sound commercial operation of the services provided by the satellite navigation system must be taken into account when the programme specifications are drawn up - without which any subsequent adjustment to those requirements is likely to increase the system costs significantly.

Ensuring that the technical risks attached to the project are kept under control by funding prior studies.

Providing a single public management structure[41] is proving to be an essential prerequisite for reassuring potential investors as to the institutional stability of the project and to complete an adequate funding schedule.

The predictive timetable for the intended spending would have to be accompanied by an identification of the sources and amounts of public funding throughout the various stages of the project, from the development and validation phase up to the deployment phase for the constellation and the corresponding ground-based installations.

All of these conditions should be met by 2003 provided that a firm decision on continuing the programme is taken in December 2000.

Active inclusion of private partners from the system's initial development and validation phase should enable not only the overall cost, but also the provision of effective management and cost-control systems to be optimised. Moreover that involvement will help in drawing up commercial-operation and cash flow management schedules that are associated with the services provided.

It would seem that the contributions expected from private partners could cover a wide range of areas spanning both involvement in kind and direct financial contributions, including the development of equipment, carrying out pilot projects, acquiring operating licences or transferring technological and commercial know-how.

However, despite the encouraging long-term forecasts, the length of the period of return on investment virtually requires deferred funding of the deployment phase.

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[40] See in this connection item 10 in the conclusions reached by the Transport Council on 9.10.97: *"... TEN projects require a firm political commitment on the part of the Member States, including from the PPP point of view, and welcomes the Commission's willingness actively to support efforts to establish PPPs, the identification of which will be the responsibility of the Member States"*

[41] See in this connection item 5 of the conclusions reached by the Transport Council on 9.10.97: "*considers that it is essential that a climate favourable to PPPs be created both at national and at Community level and stresses the need for private sector involvement from the outset in the preparation of PPP projects, while keeping a balance between commercial and socio-economic criteria in the planning of the projects, and the need for appropriate risk-sharing"*

There will have to be a detailed description of the background to and machinery for selecting the various partners and private investors in order to give the partnership an optimum balance in the light of the successive phases referred to above. Compliance with the rules of the World Trade Association also has to be ensured.

3. Benefits provided by Galileo

A detailed cost-benefit analysis of the Galileo system is set out in a Commission working document. This is based on a macro-economic approach which emphasises the net gains to be had from setting up and running Galileo. It only provides the information needed to aid the decision to carry out the project.

Europe's crucial dependence on the American GPS in several strategic and commercial applications is still escalating. It is possible to quantify that dependence by using data concerning the current and potential use of GPS on markets linked to positioning and dating services (principally the transport, communications and finance sectors). The cost of a sudden halt (for whatever reason) in the sale of those services for just a few days, without counting the system destabilisation resulting from that halt would amount to €1 billion in 2015. That strategic factor must naturally be taken into account when analysing all of the benefits provided by Galileo.

The advantages set out in the cost-benefit analysis concern only the extra activities generated by Galileo as compared with the current situation of a GPS monopoly, otherwise known as "zero option", and the emergence of positioning systems by mobile telephony networks (GSM, UMTS, etc.). The existence of two independent but interoperable systems highlights new areas of application and use and speeds up the introduction of navigation systems into several areas where double sourcing is important. For example, the occultation constraints inherent in the majority of urban landscapes reduce the availability of positioning service supply to some 55% of the territory, whereas the two satellite constellations together increase this availability to 95%.

Numerous factors help to highlight the difference that should attract, and even create in some cases, a significant market for Galileo. On the one hand, the high reliability of the system makes for a system of guarantee and liability that would be hard to imagine with existing satellite navigation systems. On the other, taking account of its existence and, in some cases, the direct incorporation of other infrastructures, other services (UMTS) and local factors into the basic design of the Galileo system will ensure complete compatibility across the whole chain of services provided to users. A practical example of this would be the sector of insurance, monitoring of marine pollution and civil aviation, as a precursor to the use of satellite navigation.

As regards methodology, the overall assessment based on changes in current markets provides estimates which are being supplemented and validated by the second system set up during Galileo's definition stage, namely consulting potential navigation-system users and service suppliers (road, rail, air and sea transport, communications and infomobility processing systems, scientific research, etc.). Summarising the data acquired has enabled the orders of magnitude in the various areas of application to be better defined.

By way of a guide, market estimates for satellite navigation products and services suggest that Galileo's market share could run to €9 billion in 2015. The inclusion of a positioning service in mobile telephony applications will probably one of the main reasons for the spectacular increase in the use of these services (see Annex 1).

With Galileo Europe will gain a foothold on the market of satellite navigation products and services, which at present is totally dominated by other players, led by the US. This will have a positive impact on the competitiveness of European industry. Mobile telephones or even lap-top computers will incorporate a positioning chip in the not too distant future. The demand that this creates should enable Europe to step up its production of components and to add to its hand in the area of integrated systems and services, particularly motor vehicle navigation and telematics services.

The macro-economic cost-benefit analysis has thus helped to quantify the greater net economic gains for producers[42] (constructors of space systems, manufacturers of receivers and application, service providers, etc.), on the one hand, and the "social" benefits, on the other, such as greater safety in means of transport, greater fluidity in traffic, more efficient road transport and less emission of noxious gases, etc. The analysis also focuses on the strategic value of Galileo, not just in terms of the compatibility of its infrastructure with existing systems, but also as a possible tool for implementing European policies on transport, agriculture, environment, etc. The hypotheses underlying the analysis are limited to a very conservative range of values, e.g. for reducing congestion in road traffic only a small percentage will be down to Galileo, despite a number of fairly promising results from other studies.

The results obtained from the macro-economic analysis clearly show the need for Europe to put in place a navigation system as soon as possible. The high rates of return indicated by the analysis show, unsurprisingly, the intrinsic value of a system of this kind and the need to involve the public sector in the initial funding of the project. Given the size of the markets and the profits, manufacturers will be increasingly keen to be part of it and the private sector will doubtlessly be a major player as from the deployment stage.

4. <u>Cash flow</u>

The use of Galileo is likely to generate several types of specific income, which are described below. The first may arise from three services (of general, commercial and public relevance) provided, while the others will come only from controlled-access services.

1. <u>The potential cash flow from all Galileo services</u>

The Commission needs to look at how to introduce a duty on receivers.

A duty based on industrial (or intellectual) property rights

A second source of income could be based on Community legislation enabling holders of industrial (or intellectual) property rights to receive a royalty on their inventions. This already applies to music and books (royalty on recordings and photocopies). That could easily be extended to Galileo receivers.

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[42] At macro-economic level, any outlay on navigation equipment and services by consumers, who have fixed purchasing power, will limit their purchasing power for products from other sectors, which will mean a modest overall gain for producers as a whole. On the other hand, Galileo will obviously generate huge market potential and thus gains for the manufacturers of navigation equipment and providers of services.

A quality label

A quality label granted by the Galileo's operator would consist of a sort of stamp on the receiver certifying that the product is approved by the operator. Such a system would of course not be obligatory. It could be accompanied by certain guarantees.

The operator could grant service-quality certification - similar to ISO certification - to suppliers of Galileo services. This would be a sales argument in favour of an approved service enabling reliable use to be made of the signal supplied by a service provider.

Certification of this type would boost confidence in the Galileo system, but it would not replace the certification required by the public authorities for "vital" applications such as aviation.

2. <u>The cash flow generated by the commercial service and by the public-interest service in the case of "vital" applications</u>

A licence fee

A fee of this type would be considered to be a means whereby a service could generate income. Provided that the means to control use of the signal were available the Galileo operator could conclude licence contracts with value-added service providers.

A sequence of licence contracts would enable a cascade of income to be generated by the commercial service.

A PIN code

A PIN code in chips inserted into receivers (similar to that in GSM mobile phones) could enable a service to be introduced with controlled signal access. In practice users must enter a code in the receiver in order to activate this for receiving Galileo's signals.

Concluding a contract between the Galileo operator and the receiver manufacturers is needed in order to implement that option. The access codes will form part of the contract drawn up between the operator and the service provider. The income would come from the final user on acquiring a PIN code for his receiver.

A contribution from non-member countries using the system

Non-member countries or regional international organisations wishing to invest in Galileo could make a financial contribution in exchange for the right to use the commercial service, with certain guarantees. That would enable Galileo to be promoted and add impetus to the standardisation process.

Part 3: Management structures

Currently the Galileo programme's management is shared between the Commission and the European Space Agency, each of whom manages a certain number of contracts intended successfully to complete the programme's definition phase in accordance with their own administrative and budgetary rules. One particular consequence of this is that the Commission and the European Space Agency refer here to two different "steering committee", the first consisting of the Member States of the European Union and the second the Member States of the European Space Agency. The Programme Management Board (the PMB) comprising a representative of the Commission and one of the European Space Agency is attempting, with assistance from a coordinating office (the GPO), to compile the results of the activities undertaken and to draw up a coordinated plan for the future.

In view of the increasing complexity of the activities to be undertaken from 2001 onwards and of the amounts of money involved, continuing with the programme needs to tie in with budget management so as to guarantee that the activities conducted by the Commission, a political institution, and the European Space Agency, a technical organisation, are complementary.

1. The interim structure

Until the final structure is provided, a coordinated management framework for Galileo has to be established as from the beginning 2001, clearly assigning political responsibility to the Commission and technical responsibility to the European Space Agency.[43]

This will take the form of:

1. regular, joint meetings of the two steering committees already set up by the Commission and the European Space Agency designed to define the strategic approaches of the programme, given that both committees already have their own terms of reference and rules;

2. technical management by the European Space Agency as part of a service-provision contract with the Commission.

2. The final structure

The final structure has to follow on from the interim structure. It has enjoy a certain amount of legal and financial independence in respect of its backers and be the contracting authority for Galileo. It will thus have a budget combining all the funds for the programme. Once the Galileo system is operational it will have to be managed by a private body (responsible for marketing the services provided by Galileo and system maintenance) subject, of course, to the relevant Community rules.

The Commission will submit the respective proposals.

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[43] In accordance with the resolution on a European space strategy adopted on 16 November 2000 by the Research Council.

Conclusion

The Commission takes the view that:

– satellite radio navigation is a key technology for the development of our economies and that the deployment, to that end, of a constellation of EU satellites is indispensable to safeguarding our independence;

– cost/benefit studies show Galileo to be cost-effective and sufficiently attractive to obviate the need for any further public funding in the form of subsidies from 2007;

– for the development and validation phase (2001-2005), the essential funding from public subsidies has been so planned that there is no need to call upon additional public contributions, under budgets of the Community or European Space Agency;

– the funding of the deployment phase, comprising the construction and launch of satellites and the establishment of the ground-based infrastructure network, will require private-sector investment of some €1.5 billion; and that an appropriate public–private partnership will be in place in time for the development and validation phase;

– the setting-up of a public-private partnership requires a legal and financial framework as soon as possible.

  - A coordinated, provisional management structure for the Galileo project, involving the Commission and the European Space Agency, should be set up by 2001.

  - The proposals needed to set up the final structure with an investment budget combining all the funds earmarked for the project will be drawn up by the Commission.

  - Egnos should be controlled by this structure.

  - A report will be made each year to the Council and to the European Parliament on the progress made in this area, and on the setting-up of the programme management structures, and to describe the funding of the deployment phase (2006-2007) by December 2004.

ANNEXES

Annex 1: The satellite navigation market

Size of markets and breakdown by application sector

(i) Summary table of the market (€ billion)

	1999	2005	2015	2020
	GPS		Market share due to GALILEO in a GALILEO + GPS environment	
Europe	1	6	7	11
World	-	-	22	42

(ii) Size of European satellite navigation market 1999 – 2005

Market sector	1999 € million	2005 € million
Aviation	40	70
Maritime trade	15	20
Road vehicle navigation	700	2000
Fleet management	40	90
Rail	1	25
Cartography	50	100
Agriculture	5	10
Signal improvement	50	60
Mobile communications	0	3000
Dating	5	10
Personal navigation	50	100
Defence	300	500
Total market	**≈ € 1 billion**	**≈ € 6 billion**

(iii) World Galileo market in 2015

Application	2015 € Million
Drivers (all vehicles)	12600
Location/communication services	5100
Pedestrians	1500
Vehicle management	900
Vehicle tracking	600
Recreational craft navigation	190
Personal navigation	120
Route finding	110
Cartography	100
Emergency services	150
Other	750
Total	**≈ € 22 billion**

Annex 2: search and rescue (SAR)

The Galileo Programme provides a search and rescue service for users based on the humanitarian and public service principles of the international Cospas-Sarsat system, while at the same time making search and rescue operations more effective.

Present system

The Cospas-Sarsat system consists of four low-orbit satellites and three geostationary satellites, which can pick up sea and air distress signals and identify their location. This information is then forwarded to Mission Control Centres, and then in turn to Rescue Coordination Centres, which organise and initiate rescue operations.

The countries which set up the system are the USA, Canada, France and Russia. Many countries, including countries in Europe, have their own data processing centres.

Expected improvements

The following table shows current performance of the Cospas-Sarsat system and the expected performance of the SAR Galileo system:

Criteria	Cospas-Sarsat	Galileo
Return link to user	No	Yes
Time taken for transmission of distress signals to search and rescue centre	Up to one hour	Approx. 1 minute
Coverage	Restricted	Global
Accuracy	Several km	10 m
Number of false alarms	> 90%	< 10%

The search and rescue service will be improved by combining the conventional distress signal detection system using the 406 MHz waveband with the positioning capabilities and permanent coverage of Galileo. The aim is also to establish additional links to ensure the transmission of distress signals, and organisation of rescue.

Performance of the present system will be improved by using the constellation of 30 satellites and their corresponding ground sectors, with the following advantages:

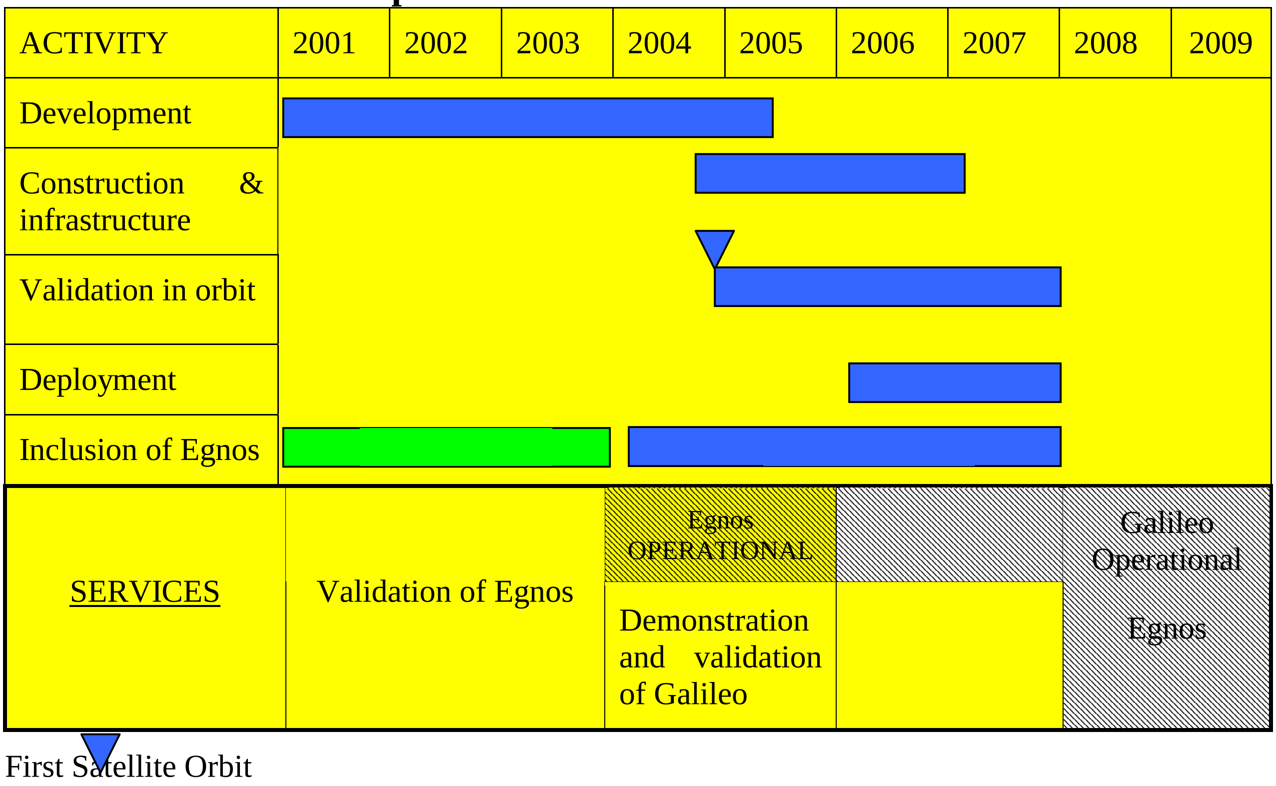
- continuous coverage by a number of satellites of any point on the earth’s surface, including the polar regions;
- shorter transmission times because each satellite is always visible from a ground station;
- highly accurate positioning data, because of the use of receivers incorporated into beacons and by improving the “Doppler” positioning accuracy of beacons not equipped with Galileo receivers;

- improved probability of detecting distress signals because of the simultaneous visibility of several satellites at different angles of elevation;
- reduced size and cost of distress beacons as a result of system performance and technological integration capacity by 2008.

Not only will this considerably improve the existing system but there are also plans to incorporate new services, most of them based on establishing a communication link with the people in distress. Return links to users will allow rescue teams to reassure victims that they have received their distress signal and are organising a rescue operation. Return links will also make it possible to develop other applications such as removing doubt (in cases of false alarms or presumed accidents), preventing accidents (by warning of danger), and coordinating rescue operations on the spot.

Establishment of a search and rescue service by Galileo will prompt the Member States of the European Union to participate in the Cospas-Sarsat search and rescue programme, alongside the Member States which have signed the intergovernmental agreement and the suppliers of the space sector (USA, France, Canada and Russia). This will demonstrate at international level that they are prepared to participate in a major humanitarian programme.

Annex 3: Galileo Development Plan



Annex 4: Integration of Egnos into Galileo

1. Background

As requested by the Council in December 1994[44], Egnos was designed as a supplement to GPS and Glonass. Egnos is also Europe's first satellite navigation project.

Egnos will provide its users with enormous economic benefits and should eventually make it possible to do away with a number of conventional navigation facilities.

However, the potential advantages of the system are hampered by a number of limitations: it is totally dependent on the GPS constellation, which is completely outside Europe's control; its geostationary satellites do not fully cover the Nordic regions of Europe, and the concept was implemented on a regional basis (Europe, North America) rather than globally.

One of the reasons for developing Galileo is the need to overcome these limitations (but also to provide new services).

Egnos includes a dysfunction warning system (the integrity concept) which the GPS and Glonass constellations do not have. This service is essential for those users in the transport sector who require a reliable GPS signal. The Egnos service will also meet an international civil aviation standard.

The rapid commercial introduction of Egnos will not only open a new market but will also encourage partnership in the future with those who do not have Galileo.

The infrastructure required for Egnos will gradually be integrated into the Galileo infrastructure, while maintaining the minimum requirements to supply a service which meets international standards until approximately 2015.

The Egnos and Galileo infrastructures will have to be integrated and managed centrally.

2. Integrating Egnos into Galileo

Architecture

As it emerges from the definition phase, Galileo will enable the best possible integration of Egnos. This will be done in three stages.

During stage one, starting in 2003, Egnos[45] will allow the early introduction of a guaranteed service based on a system for warning of GPS failures (integrity).

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44 Council Resolution of 19.12.1994 on the European contribution to the development of a Global Navigation Satellite System (GNSS) – OJ C 379, 31.12.1994, p.2

45 The Egnos ground segment will consist of:
reference stations to receive data from satellites;
control centres to process this data and monitor the whole system;
up-link stations to send information back to the geostationary satellites;
a network for communicating between ground installations.
The Egnos space segment will consist of three geostationary satellites; two which are currently leased from Immarsat and a third, Artemis, which is being developed by the European Space Agency

By 2008, the Egnos infrastructure will have been integrated into the Galileo architecture, once Galileo starts to operate. As a result of this integration:

– the configuration of Egnos control centres and other infrastructure will be rationalised so that they also become one of Galileo's control devices;

– the Egnos reference stations and up-link stations will be maintained;

– Egnos' communication capabilities will be reinforced for integration into Galileo's ground segment;

– the geostationary satellites will be kept in operation until around 2015 with navigational payloads.

After this date, the GPS service, with guaranteed integrity, will be provided entirely by Galileo, and possibly by GPS III itself. The long-term optimisation of the Egnos ground sector should provide users with a better service at lower prices.

Management

Egnos will be incorporated into the client structure established for Galileo.

In 2001 the Commission of the European Communities, the European Space Agency and Eurocontrol, the European Tripartite Group currently implementing the Egnos system, will launch a procedure to select the body to operate the Egnos system.[46]

A contract will be signed with the operator selected for the management of Egnos. It will be a limited-term contract and will have to be reviewed before the date on which Galileo is put into operation.

[46] In 2001 an operator will be selected to manage Egnos infrastructure on the basis of an agreement covering:
the level of service required;
operating costs;
liability for system dysfunctions;
commercial policy;
sources of income and methods of collecting revenue;
interoperability with existing regional systems

Annex 5: SUMMARY DESCRIPTION OF GALILEO

SERVICES

Galileo is a non-military programme. Its coverage is global and it provides three services.

1. **General service**:
   - free access to signals;
   - no information on the integrity of the system used.

2. **Commercial service**:
   - restricted access;
   - integrity information available;
   - excellent time accuracy (100 nanoseconds).

3. **Public service**:

Services related to personal safety:

– information on signal quality (integrity: users are warned of anomalies within 6 seconds);

– service available 99.9% of the time;

– restricted access;

Services allowing the public authorities to regulate or operate certain activities (e.g. transport)::

– same performance levels;

– guaranteed service with certified controlled access.

Search and rescue:

– activated by distress signals;

– acknowledgement of signal sent to distressed person immediately.

All these services allow two-way exchange of individual messages defining the location by using existing systems (or using Galileo satellites - option available until 2001).

SYSTEM

1) Signal:

Each service requires simultaneous broadcasting on two frequencies;

The basic solution presented in this paper uses:

a frequency scenario consisting of the wavelengths allocated to CMR 2000 (option terminates in 2001);

a possible scenario requiring negotiation with the Russians or Americans which should help to improve the performance of the services provided.

2) Architecture

Constellation of 30 satellites orbiting at average height;

The whole system has a level of security equivalent to that of sensitive public infrastructure

The system is global with integrity distributed throughout the world. It also allows each region (a maximum of eight over the globe) to personalise its integrity signal

Local relay stations (at airports, ports, towns, etc.) make it possible to receive signals in confined spaces: studies into defining and manufacturing prototypes have been financially accounted for; on the other hand, this is not the case with deployment of the corresponding infrastructure, which will be funded by the provider of the service concerned.

TIMETABLE

- **Galileo**

* **Development and validation phase** (2001-2005)

  - Al the detailed definition of sectors (space, ground, user):
  - Development of satellites, ground components;
  - Validation of the system "in orbit".

* **Deployment phase** (2006-2007)

  - Building and launching satellites;
  - Establishing the entire ground sector:
  - Integrating Egnos.

* **Operational phase** (2008 onwards)

  - Renewing satellites, running centres, maintenance.

- **EGNOS**

This is a land-based infrastructure which will make it possible to augment the integrity of the GPS system using geostationary satellites for users equipped with a special receiver.

* **Development phase** in progress - 2003
* **Operational phase - Egnos only** 2003 - 2008
* **Operation alongside Galileo** 2008 onwards
  (integration of land-based infrastructure)

SUMMARY

Budgetary estimates are based on the various assumptions given above, including integration of Egnos.

* **Validation phase** € 1 100 million

* **Deployment phase** € 2 150 million
* **Operational phase** € 220 million/year

ANNEX 6: LIST OF STUDIES

There are several packages of studies:

1. GALA

The objective of this package was to provide the mission specification, the global architecture and system specifications for GALILEO. The programme included the interfacing with the other activities carried out during the GALILEO definition phase, to ensure that the architectural design was co-ordinated and coherent

Documents carrying a security restriction are not included on the distribution list.

Doc No	Document Title
Dd001	Applications Definition & Sizing - Executive Summary (dd001)
Dd005	Market Research Methods and Overall Results (Volume 1)
Dd005	Market Research Methods and Overall Results (Volume 2)
Dd043	Overall Architecture Definition – Component definition
Dd058	PILOT PROJECTS - Synthesis of LLD (dd058 v1)
dd067	Development plan.
Dd087	Conclusions and Recommendations
GALA	**Trade-Off Between MEO and MEO+GEO Constellations**
GALA	Communication Service
GALA	EGNOS Integration
GALA	Synthesis on Service Definition
GALA	**Support Segment – Architecture Co-ordination**

2. GEMINUS

The aims of the GEMINUS programme were to define the services that GALILEO has to provide to meet the requirements of the international subscribers. In addition GEMINUS performed a series of case studies focused on specific aspects of the service provision chain to validate the study results.

Doc No	Description of Deliverable or Working Paper
	TECHNICAL ANNEX
D8.1	Draft Final Summary Report
D1.1.2	Galileo User Forums Report 2
D2.1	PPP Environment Interim Report 2
D4	Service Definition Report

3. INTEG

Since 1995 considerable effort has been dedicated to the EGNOS programme allowing Europe to develop expertise in the GNSS field and to build an augmentation system for GPS and GLONASS. The objective of the INTEG study was to analyse a seamless transition from EGNOS to GALILEO from technical, economical, operational and institutional points of view.

REF	TITLE
INTEG-ASPI-D2.1B	EGNOS Integration into GALILEO (INTEG) Report on INTEG Requirements
INTEG-ASPI-D4	EGNOS Integration with GALILEO (INTEG) Galileo/EGNOS Interface Definition
INTEG-ASPI-D3	GNSS-1 Programme Implementation Phase EGNOS Integration with Galileo (INTEG) Report on Proposed EGNOS upgrades

4. GALILEOSAT

The GALILEOSAT programme covered the definition of the GALILEO space segment (the satellite constellation) and of its related ground system.

DOCUMENT TITLE	Reference	Issue
SYSTEM		
Architecture definition	ADD/GAL/0020/ALS	2
System Verification Plan		
SPACE SEGMENT		
Space Segment Definition Report	GALI-ASMD-RP-0100-0001	1
Navigation Payload Definition	GSAT.RP.00001.P.ASTR	1
GROUND SEGMENT		
G/S Baseline Definition	GSAT.SP.00002.P.MMS	1

5. SAGA

SAGA was designed to set up a platform for continuous standardisation activities up to the operational phase of GALILEO. By establishing, through international bodies, a worldwide recognition and interoperability between GALILEO and other systems such as GPS and GLONASS, SAGA contributes standards for Galileo to be adopted inside and outside Europe

Doc No	Output WP No	Description of Deliverable or Working Paper
D1	WP1000	**COMMON STANDARDISATION ISSUES AND BASELINE FOR GALILEO**

6. SARGAL

This project is to study the possibility of providing search and rescue services (SAR) through the GALILEO satellites and also to expand these services by introducing a data link capability for feeding back an acknowledgement to the distress beacon. It is addressing the technical, institutional and operational issues with a view to replacing the current SAR (dedicated) COSPAS-SARSAT satellites by the GALILEO constellation.

Doc No	Description of Deliverable or Working Paper
D2.10	**SARGAL INTERIM REPORT**

7. MUSSST

MUSSST objective was to establish the generic principles for the safety approval of the use of GNSS by the transport community. The outcome of the study was a methodology focusing on the development of a safety case for GNSS. The methodology was validated against existing and future GNSS programmes.

Doc No	Description of Deliverable or Working Paper
D9	**MUSSST FINAL REPORT – SYNTHESIS, GUIDELINES AND RECOMMENDATIONS**

ANNEX 7: FINANCIAL STATEMENT

1. TITLE OF OPERATION

Communication from the Commission: “Galileo – results of the definition phase

2. Main Budget Headings Involved

B5-700 Financial support for projects of common interest in the trans-European network

B6-6 Fifth Framework Programme, **Information Society Technologies** (6-6121) and **Sustainable and Competitive Growth** (6-6131)

Other budget headings could be used as appropriate

3. Legal Basis

One or more of the following depending on the action taken

Articles 74, 84(2), 113, 129c and 130i of the Treaty

Decision No 1692/96/EC of the European Parliament and of the Council of 23 July 1996 on Community guidelines for the development of the trans-European transport network

Council Regulation (EC) No 2236/95 of 18 September 1995 laying down general rules for the granting of Community financial aid in the field of trans-European networks (as amended by Council Regulation (EC) No 1655/99 laying down general rules for the granting of Community financial aid in the field of trans-European Networks

Decision of the European Parliament and of the Council of 22 December 1999 concerning the fifth framework programme of the European Community for research, technological development and demonstration activities (1998 to 2002)

Other relevant documents

Communication from the Commission “Galileo – Involving Europe in a New Generation of Satellite Navigation Services” COM (1999) 54 final, 10.02.1999

Council Resolution (EC - 1999/C 221/01) of 19 July 1999 on the involvement of Europe in a new generation of satellite navigation services – Galileo – Definition phase.

Communication from the Commission to the Council and the European Parliament – ‘Towards a Trans-European positioning and navigation network: including a European Strategy for Global Navigation Satellite Systems (GNSS)’

Council Conclusions of 17 March 1998 on a European Strategy for Global Navigation Satellite Systems (GNSS)

European Parliament report of January 1999 on a European Strategy for Global Navigation Satellite Systems (GNSS)

4. Description of Operation

4.1. General objective

The Communication demonstrates the technical and financial viability of the Galileo project and proposes validation of the Galileo concept during the second stage. In fact the project envisages development of a European satellite system (Galileo) which will contribute to the implementation of a trans-European positioning and navigation network. The objective of establishment of such a network is to improve the efficiency of transport systems by placing at the disposal of users a system allowing geographical positioning and precision timing. This contributes to development of sustainable and safe mobility for persons and goods, one of the fundamental objectives of the Common Transport Policy. The project design also supports other Community policies such as for employment, industry, environment, cohesion and co-operation and development.

More specifically, a Galileo would provide added value in the form of a guaranteed high level of service, making it more attractive to safety-critical and commercially sensitive users. It will also enable PPP structures to be developed, involving considerable private investment in the development of a system required for public-strategy reasons. Different possible revenue streams are identified in the Communication, some of which require regulatory action.

4.2. Period covered and arrangements for renewal or extension

Full implementation of Galileo is expected over the period 2000-08. This statement considers only EU Budget financing for the current financial perspective period of 2001 – 2006.

5. Classification of expenditure or revenue

5.1. Non-compulsory expenditure

5.2. Differentiated appropriations

5.3. Type of revenue involved

Not applicable

6. Type of expenditure

Subsidy for joint financing with contributions from other parties (including the European Space Agency, industry, national space agencies);

Research and development activities (Framework Programme)

Feasibility studies and demonstration projects (maximum Community contribution: 50%) eligible for financial aid under the TEN

Grants or risk-capital participation for investment funds under the TEN

TACIS support for training and the conversion of Russian industries from military to civil purposes, in line with the Galileo programme

Interest-rate subsidies, funded from European Investment Bank loans

Loan guarantees premium, on European Investment Fund guarantees

7. Financial impact

7.1. The estimated cost of Galileo for the next two stages is put at €3.25 billion, which will help to develop and deploy the system as such, plus a Community contribution to be determined to facilitate the emergence of the markets identified. As far as the EU budget is concerned, the cost will be met from resources already envisaged in the existing financial programming, mainly for TENs. The additional costs linked to the emergence of the markets identified will be met first from the fifth framework programme and also possibly by future research actions which are subject to decisions of the Council and the European Parliament. The Communication identifies other potential sources of revenue.

The total cost of developing Galileo, until 2007, is expected to be as follows

Cost in € million (2000)	Development and validation phase	Deployment phase	Total 2001-2007
Management & engineering	160	130	290
Satellites	240	660	900
Launching	80	660	740
Ground sector: Global Regional Local	480	380	860
Operations	70	210	280
Technology support programme	70	60	130
Galileo - Illustrative estimate	1100[47]	2100	3200
Incorporation of EGNOS		50	
Total cost			**3250**

Activities outside the development and deployment of the system as such, as will be necessary to ensure the emergence of the markets identified, are set out in the table below. The funding shown is a minimum expenditure threshold to ensure economic viability of the programme as a whole. Other funding (private sector) is expected to come from the public-private partnership context.

[47] This does not include support for the deployment of local components or for the development of applications and receivers which do not form part of the architecture as such.

- Development of applications - Support for user sector - Standardisation measures - Support for the deployment of local components	€30 million + pm

To sum up, the cost of the development and validation phase amounts to €1.1 billion for architecture and a budget to be determined for the deployment of local components and the development of applications and receivers.

The following indicative sources of financing at European level have been identified in the period 2001-2006 only:

Sources of finance for fixed costs	€ million
	Validation and development phase
ESA[48]	550
EC *Of which:* TEN-Transport FP5 Future research actions	580 *550* *30*[49] pm[50]
TOTAL	1130 + pm

48 Subject to ESA approval procedures.

49 Galileo will receive €30 million for the period 2001-2002 from the Fifth Framework Programme, the balance being committed in the Sixth Framework Programme.

50 The references to future research actions in no way prejudice the political decision of the Council and the European Parliament as to those actions' priorities, resources and management.

7.2. Itemised breakdown of cost[51]

€ million (current prices)

Breakdown[52]	2001	2002	2003	2004	2005	2006	2007[53]	2008	Total
Tens (B5-700)	100	170	80	70	70	60	*pm*	*pm*	*550 + pm*
Research (B6-6)	30	-	*pm*[54]	*pm*[54]	*pm*[54]	*pm*[54]	*pm*	*pm*	*30 + pm*
Total	*130*	*170*	*pm*	*pm*	*pm*	*pm*	*pm*	*pm*	*300 + pm*

The annual breakdown of financing is provisional, and will depend on both the phasing of the project and the availability of funding.

8. Fraud prevention measures

The fraud prevention measures contained in each of the instruments proposed to finance the different operations will apply. These include inspections, reporting, monitoring and evaluation under Regulation No 2236/95, as amended, laying down general rules for the granting of Community financial aid in the field of trans-European networks: in particular, Articles 12(4) and (5) provide for regular on-the-spot checks by Commission staff and Articles 15(5) and (7) provide for monitoring and evaluation. Similar measures exist for the other Community financial instruments involved.

9. Aspects of cost-effectiveness analysis

9.1. Specific and quantified objectives; target population

Reference is made to the Commission working document on the results of cost-benefit studies.

9.2. Grounds for the operation

The Community contribution should be seen in the context of the measures to implement the guidelines for the development of the trans-European transport network, particularly the navigation and positioning network and the Common Transport Policy. Organising co-operation on the basis of a clear strategy using the resources available in Europe is the only means of ensuring a role for Europe in the development of GNSS.

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[51] Figures applicable from 2001 are illustrative and depend on the approval procedures of the respective instruments. The table considers only Community instruments (and not, for example, ESA funding)

[52] 2001-2005 = development and validation phase; 2006-2007 = deployment phase: 2008 = beginning of operational phase.

[53] The contribution of the Community budget to the funding of Galileo for 2007 will be examined as part of the process of preparing financial forecasts relating to the period after 2006.

[54] The references to future research actions in no way prejudice the political decision of the Council and the European Parliament as to those actions' priorities, resources and management.

- In its Communication, Towards a Trans-European Positioning and Navigation Network, (COM (98) 29 of 21 January 1998), which was endorsed by the Council in its Conclusions of 17 March 1998, the Commission set out the need for efficient and cost-effective navigation systems, for civil use but compatible with military needs, high levels of safety with adequate European control for safety-dependent systems, and opportunities for European industry in the emerging satellite navigation markets.

- The Commission recommended in its Communication on Space (COM (96) 617 final of 4 December 1996) the preparation of a specific action plan to develop GNSS as a key space application for European industry.

- Council Resolution C 221 of 19 July 1999 (1999/C 221/01)

- Commission Communication “Europe and Space : turning to a new chapter” (COM 597 final of 27 September 2000).

It is necessary to rely solely on public funds during the development and validation phase as the private sector is unable to free funds needed at the same speed, given the estimated timetable for the initial return on investment. The private sector will come on board as from the deployment phase to the tune of €1.5 billion.

9.3. Monitoring and evaluation of the operation

The operation must be monitored and evaluated with the aid of the Program Management Board on the basis of the following criteria:

- Evaluation of the conclusions of the definition phase
- Credibility of specification for the various system components
- Consistency of component construction with specifications
- Validation of land components
- Validation in flight after launch of the first experimental satellite
- Validation of Galileo system (ground and space segments, user receivers)
- Evaluation of private investment

Evaluation is important for the continuation of the programme in that moving on to the subsequent phases will depend on results.

10. Administrative expenditure (Part A of Section III of the General Budget)

The requirements in human and administrative resources must be covered by the budget allocated to the operating DG.

10.1 Effect on the number of posts

Type of post		Staff assigned to managing the operation	Source	
		Permanent posts	Existing resources in the DG or service concerned	Additional resources
Officials	A	5	5	None
	B	2	2	
	C	2	2	
Total		9	9	None

Type of post		Staff assigned to managing the operation	Source	
		Permanent posts	Existing resources in the DG or service concerned	Additional sources
Temporary agents out of research budget	A	2	2	None
	B	-	-	
	C	1	1	
Total		3	3	None

10.3. Increase in other operating expenditure as a result of the operation

Budget heading (number and title)	Amount *(€)*	Method of calculation
END (B6-6130)	148 604	4 END paid 2 END not paid
AUX (B6-6130)	78 320	2 AUX-C
INT (B6-6130)	44 238	1 INT-C
TOTAL	271 162	

Budget heading (number and title)	Amount *(€)*	Method of calculation
A-7010 (Missions)	105 000	150 annual missions within the Community 25 annual missions outside the Community
TOTAL	105 000	