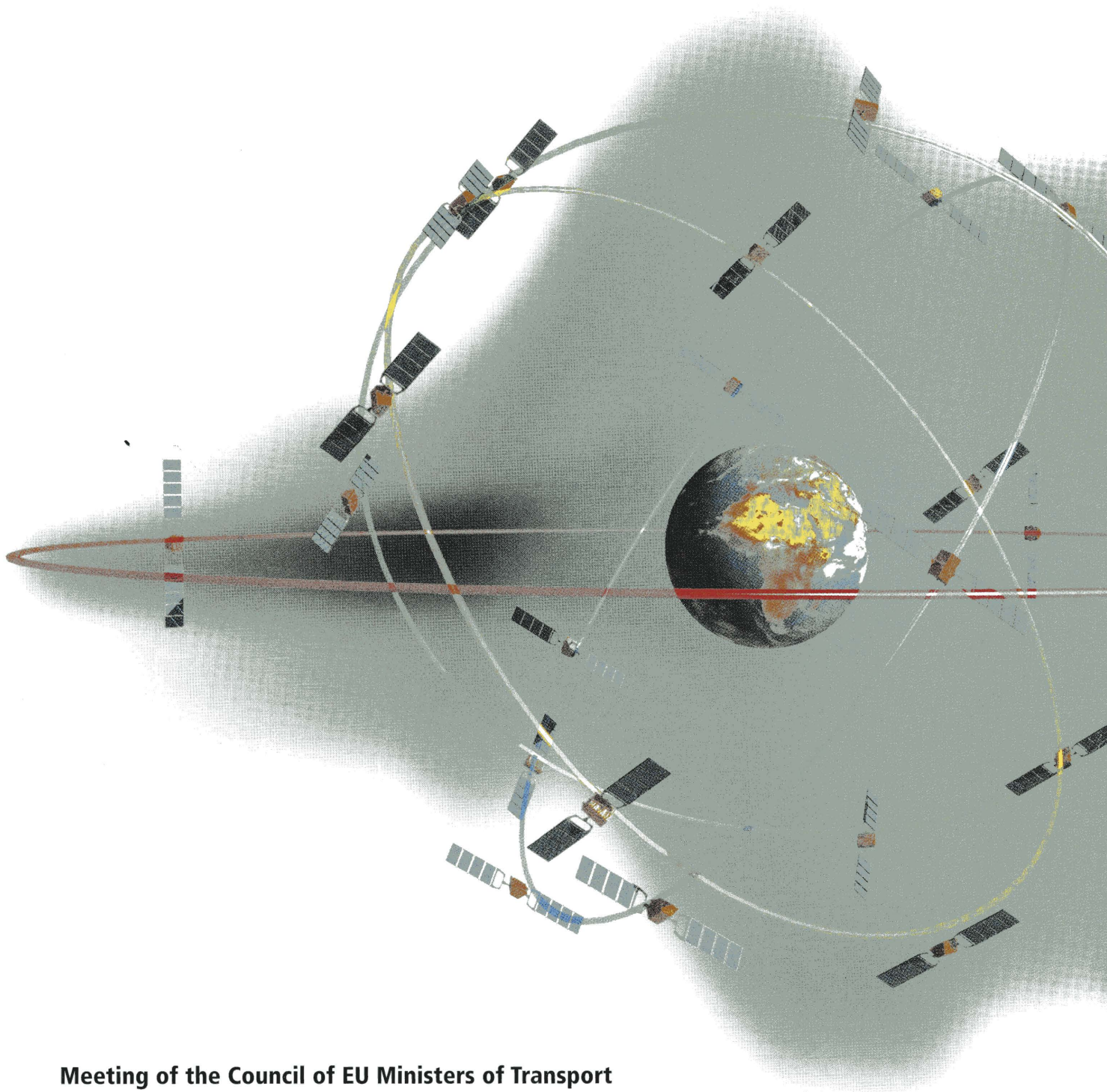


Galileo

Global Satellite Navigation Services for Europe



Meeting of the Council of EU Ministers of Transport
Luxembourg, 17 June 1999

The Most Frequently Asked Questions on Galileo

What is satellite navigation?

What is Galileo, what is GalileoSat?

What are the user benefits of Galileo?

What are the applications of Galileo?

What are the macro-economic benefits of Galileo?

What is the political dimension of Galileo?

How is Galileo to be financed?

How is Galileo to be managed?

What is the schedule of Galileo?

How to co-operate at international level?



Navigation satellites broadcast signals which are used by a receiver to determine precisely its position, velocity and time. Satellite navigation systems support an unlimited number of users.

4

Galileo will be a global navigation satellite system under civil control. It will consist of 21 or more satellites, depending on the level of international co-operation, the associated ground infrastructure and regional/local augmentations. GalileoSat is the complementary development initiative of the European Space Agency (ESA) for the space and the associated ground control segments.

4

Galileo offers high performance, service guarantees and liability regulations depending on the service class chosen by the individual user.

5

Galileo will be used in all modes of transportation for navigation, traffic and fleet management, tracking, surveillance and emergency systems. As such, Galileo will be a key element of the future inter-mode traffic management system. Moreover it has many non-transport applications.

6

Macro-economic benefits totalling € 90 billion are created through additional equipment, sales and services during the service introduction and the first 15 years of operation. In these industries, Galileo will create more than 100 000 new jobs. Potential wider benefits result from the use of the system.

8

Galileo plays a major role in the European economy and provides Europe sovereignty in future traffic management and telematics infrastructure.

11

Galileo shall be financed initially by European infrastructure and development funds as well as through the ESA GalileoSat development and validation programme. Additional private sector funding shall be raised through a Public-Private Partnership scheme.

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Under the guidance of the European institutions, a "Vehicle Company" shall be responsible for development, implementation and operation. A Programme Management Board will manage the project on the customer side.

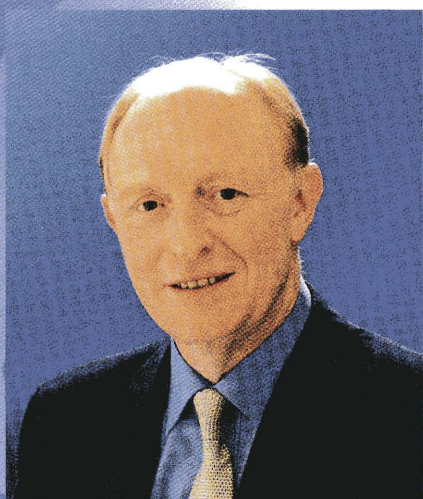
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Taking the current planning, Galileo will be fully operable in 2008 at the latest, with start of signal transmission in 2005.

14

Galileo and GPS will be interoperable and compatible. International partners will be involved actively in the Galileo programme.

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The answers by the Rt. Hon. Neil Kinnock, member of the European Commission, responsible for Transport including trans-European network.

What is Satellite Navigation?

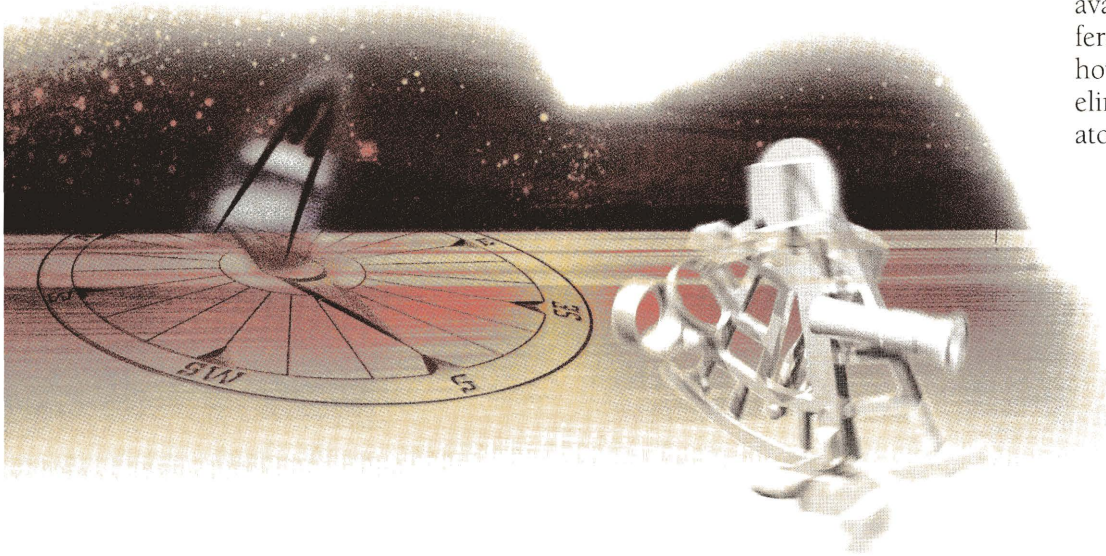
Satellite navigation is a tool to determine position, velocity and precise time world-wide. Its service can be used on land, on sea, in the air and even in space.

For centuries, sailors and other users were dependent on tracking the stars, keeping clocks running, and observing natural and artificial signs. During the last 100 years

many innovations within the field of radio-navigation created terrestrial based navigation means, used mainly by aviation and shipping. For the first time, such systems made users independent from weather conditions, i.e. visibility of stars or signs.

Satellite navigation is a new form of radio navigation. Signals transmitted from several satellites are picked up

by a receiver and used to calculate position, velocity and time. User navigation receivers measure the distance of the user equipment (receiver) to the satellites using a technique called "passive ranging". The distance to each satellite is derived from the measurement of the time the navigation signal needs to travel from the satellite to the receiver. The three-dimensional position can be calculated having available signals from at least 3 different satellites. A fourth satellite, however, is usually needed to eliminate the need for a precise atomic clock at the user.



What is Galileo, what is GalileoSat?

Galileo is an initiative of the European Union (EU) and the European Space Agency (ESA). It comprises the development, implementation and operation of a state-of-the-art global navigation satellite system. The operation of Galileo will be performed under civil control. GalileoSat is the complementary development initiative of the European Space Agency (ESA) for the space and the associated ground control segments.

Galileo is Europe's second step towards satellite navigation technology. The first step on this road is known as EGNOS (European Geostationary Navigation Overlay Service). EGNOS improves the performance of the existing military systems, GPS and GLONASS. EGNOS is being implemented with the help of the European Tripartite Group (European Commission, ESA and Eurocontrol) and a number of

European civil aviation entities. A strategy will be elaborated for the EGNOS evolution and integration into Galileo, with a view to ensuring continuity, integrity and reinforcement of the capability achieved with the EGNOS technology and infrastructure.

Within the Galileo system, 21 or more satellites will provide navigation signals to the users world-wide. Most of the satellites are in circular, Medium altitude Earth Orbits (MEO). They may be complemented by geostationary satellites, typically three over the European region. The related ground infrastructure for Galileo will comprise a global network of monitoring stations and the associated system control and Earth stations. Galileo will pursue an open system architecture, interoperable with GPS and open for augmentations depending on the specific service requirements.

What are User Benefits of Galileo?

Performance

The performance of Galileo will be much beyond the current GPS standard positioning service. Galileo will provide to all users an accuracy of a few meters.

Service Regions

Galileo is a global system providing its service all over the world. Its constellation is optimised to serve high latitude countries.

Service Classes

Galileo will offer at least two different service classes. The basic service will be available to everybody free of charge. A “Controlled Access Service (CAS)” will be offered with availability and liability guarantees. It will be available to registered users only.

Service Guarantees

Safety critical applications are applications where an undetected system fault would lead immediately to a fatal risk (e.g. in civil aviation). Safety critical applications need certification and international standardisation. Because of its civil control and related performance and service guarantees, Galileo is able to fulfil such requirements.

Liability

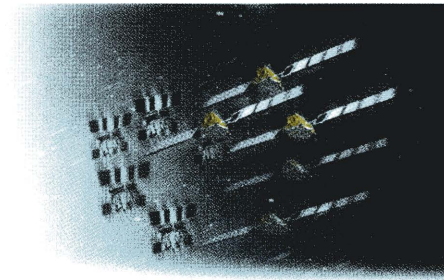
Registered users of the premium service will be backed by liability regulations limiting commercial risk in case of any system failure.

Complementary Data Communication

Many of the forthcoming value-added services are based on the positioning signal, on the one hand, and on some communication capability on the other. A dedicated communication payload is under consideration for Galileo. It may provide communication capacity tailored to real-time traffic management needs.

Compatibility and Interoperability

Galileo will constitute, together with an advanced GPS, the future Global Navigation Satellite System (GNSS). Galileo and GPS will be independent systems, but fully compatible and interoperable in order to provide maximum benefits to the users. The combined use of both signals is crucial to achieve the required performance level for certain applications.



**Performance,
service guarantees
and liability
regulations –
Galileo
is tailored to
market needs!**

What are the Applications of Galileo?

The Market

The satellite navigation market is huge – not only in quantity but also in variety. The European market for satellite navigation user equipment between 2005 and 2025 has been projected to be € 88 billion, the market for services € 112 billion in the same period. The export market for the European equipment industry created by Galileo is estimated at around € 70 billion. Altogether, this amounts to € 270 billion. The market will continue to grow significantly for many years to come, allowing European industry to participate successfully in one of the most dynamic high-tech markets.

Over the last few years, new promising markets have been created. The focus has been shifted from traditional applications such as civil aviation and maritime services, to



road traffic applications. More than 77% of the market volume is in the road traffic segment. Civil aviation, maritime and railway applications are estimated at about 1% each, but certification of Galileo services will increase their shares.

Road Applications

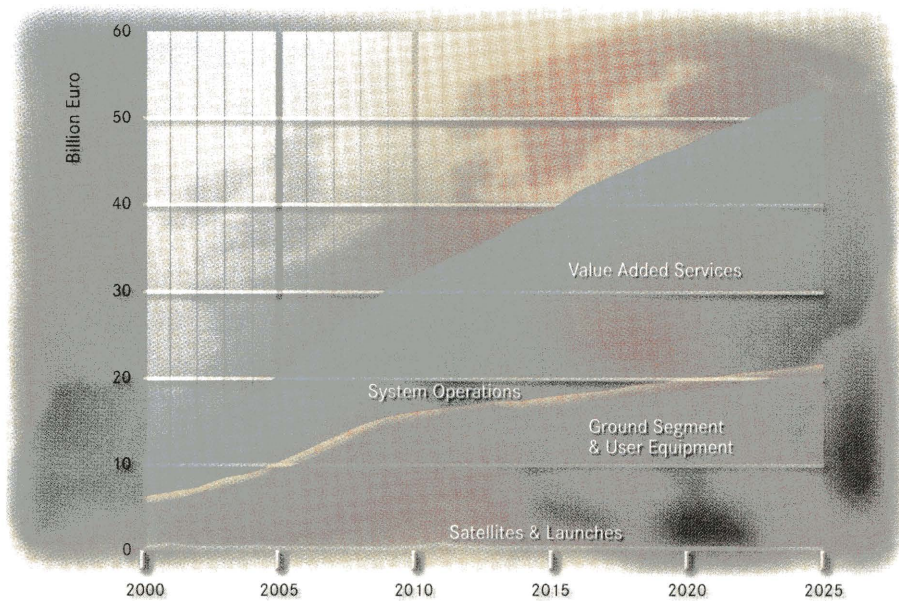
European traffic policy is facing a continuously increasing number of cars, a rising demand for mobility but limited resources to adapt the terrestrial infrastructure adequately. Thus, the need for implementation of a harmonised traffic management system based on satellite navigation and positioning service as well as on complementary data communication is the logical conclusion.

In traffic management systems based on satellite navigation, the user receives up-to-date information of the traffic and weather situation. The user's onboard navigation system will use this information together with its database, known destination and personal preferences to suggest the optimum route and speed.

Traffic Control supported by satellite navigation limits the access to a specific area's road network. Access is gained either with a licence or by paying a fee dependent upon parameters such as type of user, vehicle and time. It is one of the most effective tools in decreasing unwanted traffic in cities and stimulating the use of public transport.

Public and private fleet management allow the dispatcher of a fleet to monitor their vehicles in circulation, to regulate their frequency and to be able to plan their operations in a dynamic way.

Emergency call systems transmit the absolute positioning determined by Galileo to a call centre in the case of distress. Related devices will be a standard feature on almost every car in the future.



Profile of the world-wide positioning market

Source: Dornier Satellitensysteme GmbH

Non Transport Applications

In agriculture, satellite navigation is used to minimise fertiliser and pesticide usage and to maximise yield, a technology called “precision farming”.

Satellite positioning plays an important role in offshore exploration, both for exploration work itself, for the operation and servicing of platforms as well as for the precise allocation of claims.

The applications in surveying or geodesy are wide-spread. Satellite technology, with suitable augmentations, can for instance even help to determine deformations of dams in the millimetre range.

The satellites provide not only positioning signals but also a global time reference. The timing market, mainly for the synchronisation of communication systems and as frequency standard for power plants, is growing rapidly.

Civil Aviation

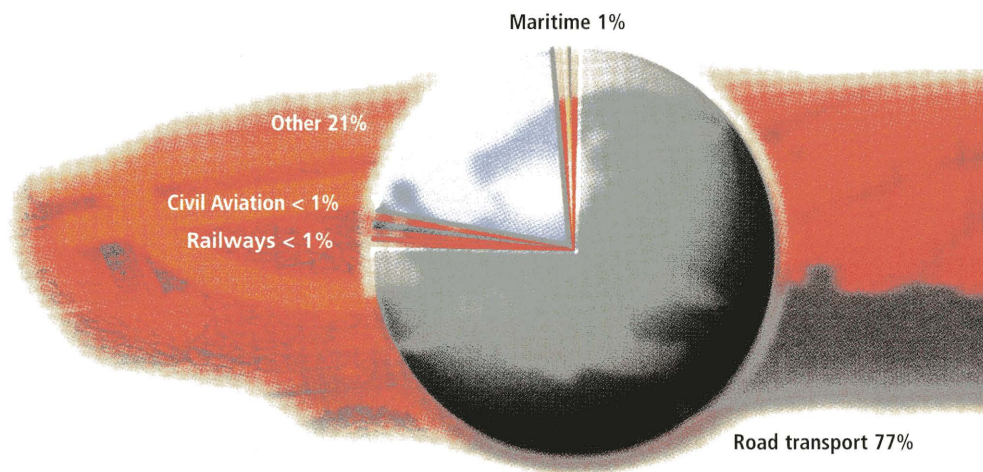
The application of satellite navigation combined with a suitable communication system will offer shorter routes, quicker access to airports through simplified navigation procedures, and, in summary, a more efficient use of the existing aircraft fleet and airport infrastructure. Moreover, Galileo will enable final approach and landing at most airports according to CAT-1 requirements, improving passenger safety and significantly reducing the cost of terrestrial infrastructure.

Maritime Sector

In the maritime sector, satellite navigation is applied for safe navigation in all phases of a voyage. It is used for fishery control as well as for container tracking and maritime distress systems. Container tracking is an excellent example of how Galileo will be used for multi-mode fleet management.

Railways

The market for rail applications is still in an early stage. However, train operators do envisage the use of Galileo for fleet management, signalling and train control.



Segmentation of user equipment market

What are the Macro-Economic Benefits of Galileo?

Macro Economic Benefits

Macro-economic benefits of Galileo result from

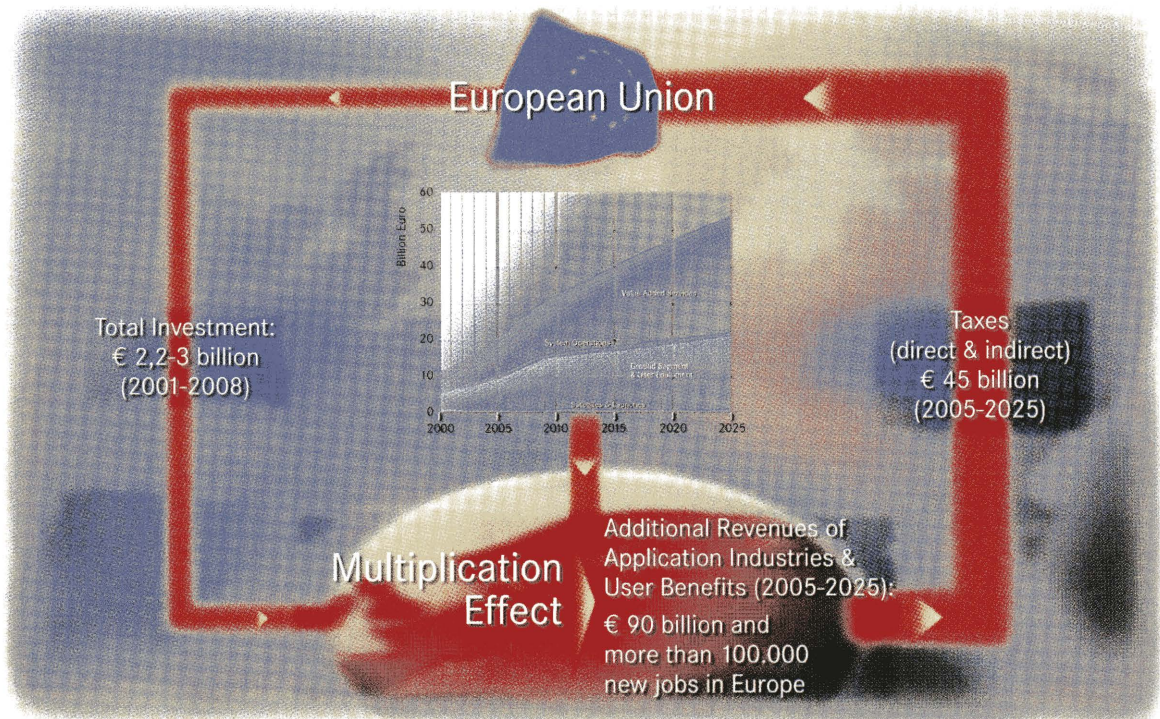
- user equipment sales and export,
- provision of value added services,
- potential wider benefits, which accrue to society as a result of the use of the system and
- development, construction and operation of Galileo.

Two different scenarios have been researched by KPMG: A scenario with Galileo and GPS operating in parallel and a scenario with GPS only. Of highest interest are the benefits for Europe that will ensue from by Galileo compared with the benefits due to GPS only. The macro-economic benefits and the employment figures are based on estimates of the investment and operating cost for Galileo. The period considered is from 2005 to 2025 corresponding to two generations of satellites

To set up Galileo, a total up-front investment of € 2.2–3 billion is needed. Once Galileo is operational, it will induce an additional macro-economic benefit by equipment sales and value added service

provision of about € 90 billion. Finally, the respective financial return to governments by direct and indirect taxes amounts to € 45 billion – twenty times the up-front investment.

Galileo – The Macro Economic Impact



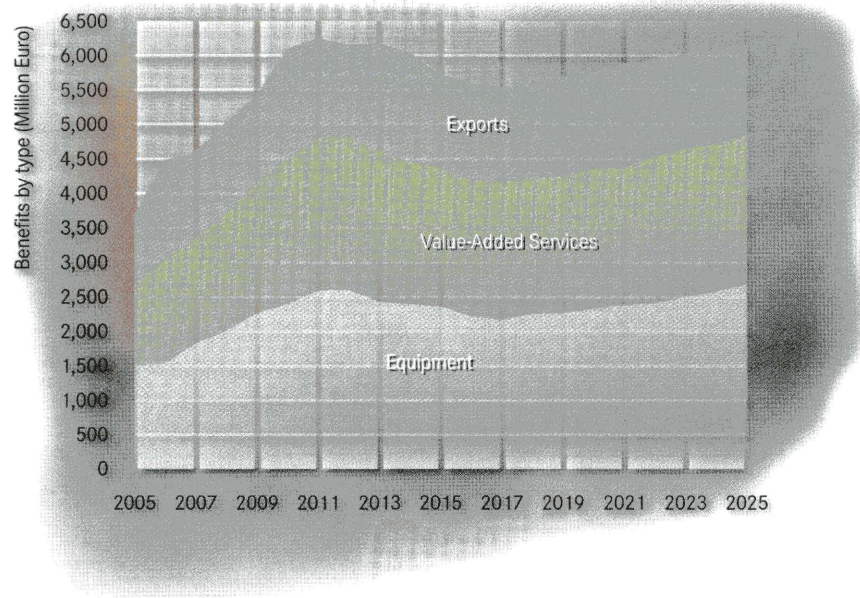
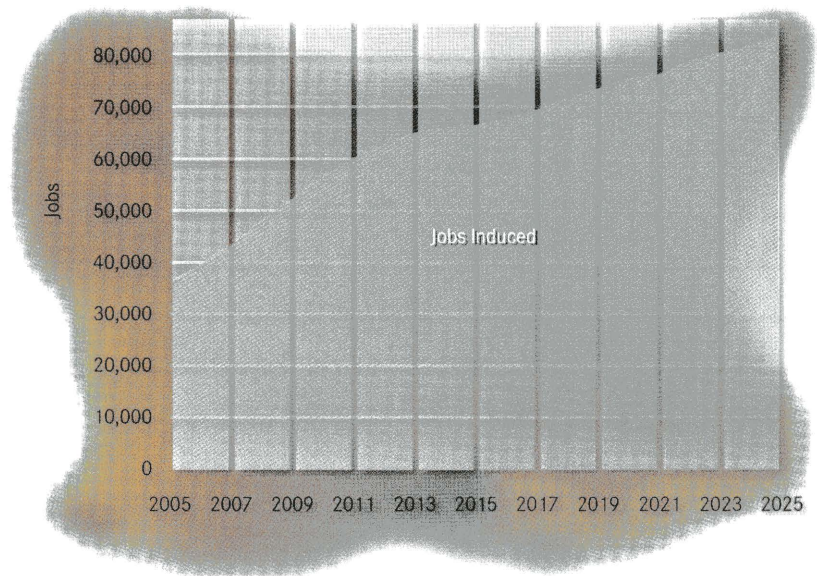
Equipment Sales

Sales of equipment provide economic benefit to suppliers and manufacturers as well as for users. Their benefit of a product or service is higher than the price paid for it.

By 2025, a total benefit of satellite navigation of € 135 billion and the creation of 146000 jobs is predicted by sales within Europe. This represents an increase of € 47 billion, accompanied by 80000 more jobs, compared with the GPS only scenario.

Considering the world market, a European share of 15-20% would correspond to an export value of € 70 billion.

The road transport market represents the dominant sector with 77% share followed by non-transport applications with some 21%.



Value-Added Services

Market volumes of services are quasi-proportional to the sales of the respective equipment. With Galileo realised, the total economic benefit amounts to € 125 billion whereas the GPS scenario would lead to just € 82 billion. Thus, in this area Galileo leads to an additional macro-economic benefit of € 43 billion and thousands of new jobs in Europe.

Development, Construction and Operation of Galileo

Economic impact of development, construction and operation of the Galileo system is moderate. Galileo supports around 20000 jobs directly and indirectly during its development and manufacturing phase and 2200 during operation.

What are the wider Economic Benefits of Galileo?

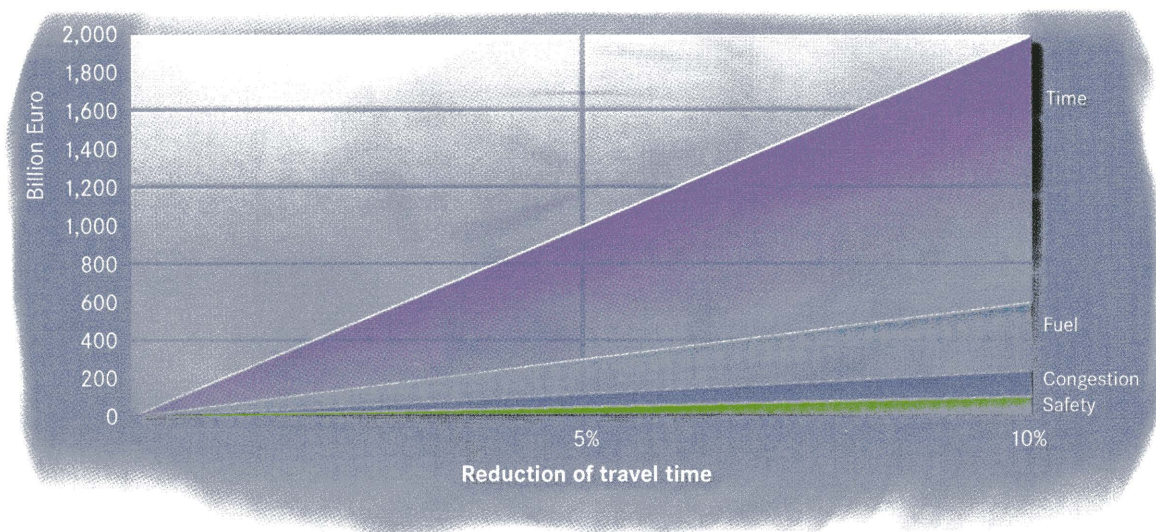
Wider Economic Benefits

Galileo will provide Europe with wider social benefits that go beyond the benefits to the suppliers and users. Essentially, social benefits and costs differ from private benefits and cost.

A common example is congestion or pollution costs where individuals do not fully recognise all costs involved in their travel decision. Another important fact is traffic safety. They are not as obvious as fuel consumption and travel time, but form an important part of indirect expenditures.

Galileo, as the core element of the future traffic management and telematics system, will be the key to reduce related costs and, in turn, to create macro-economic benefits.

In road navigation, there are € 200 billion gain for every 1% reduction in travel time and hence congestion, pollution and accidents for the period of interest (2005–2025); in civil aviation, the respective figure is about € 0.5 billion. Compared to the estimations in potential travel time reduction once Galileo is operational, just 1% reduction seems to be very conservative.



KPMG contribution to the ESA

GNSS-2 Comparative Systems

Study:

"...Transportation time can be reduced up to 30%, travelled distances will in some cases be reduced by 40%. Driver assistance systems reduce stress in 90% of the cases. Moreover, the overall level of safety will be enhanced, accidents and, consequently, the danger to life will be reduced. Moreover environmental impacts will be reduced..."

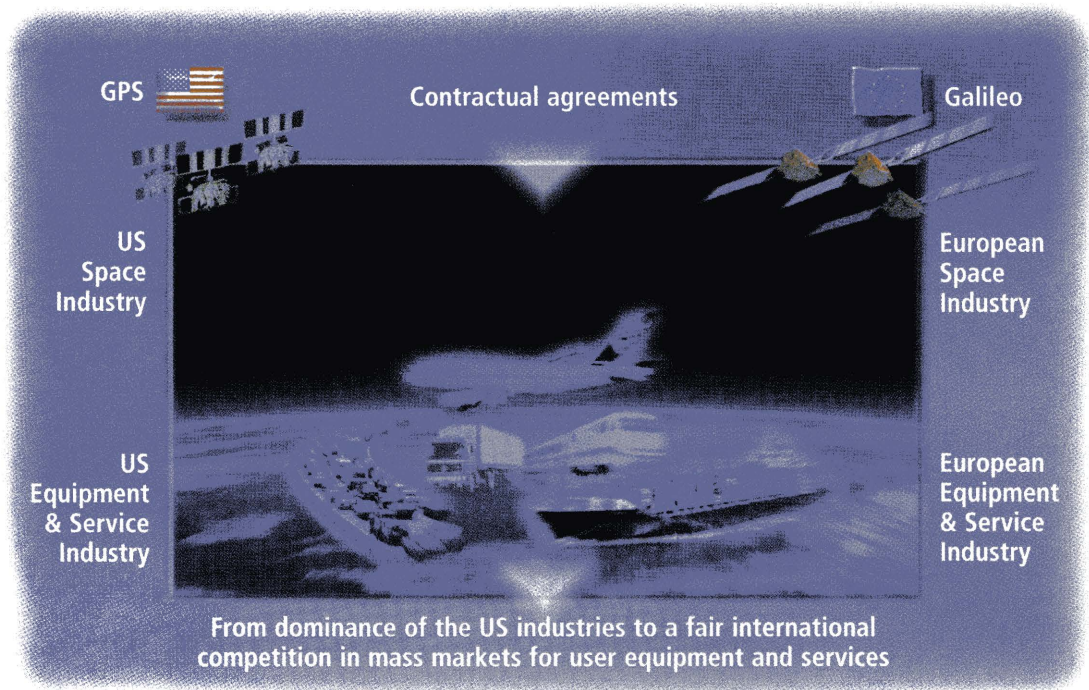
Conclusion

In between 2005 and 2025 Galileo will

- induce an additional macro-economic benefit of € 90 billion in the application industry
- create more than 100 000 new, high technology jobs all over Europe
- lead to € 200 billion indirect savings for each percent reduction in travel time in road transport alone.

Thus, Galileo is a key success factor for European industry in the next century.

What is the Political Dimension of Galileo?



Sovereignty

Galileo is the key to provide Europe its sovereignty in intermodal traffic management – in particular in safety critical services – by a system under its own, civil control.

Traffic Infrastructure

Satellite navigation will play a major role in future telematics systems and thus become an indispensable part of the future integrated information and traffic infrastructure.

Macro-Economic Benefit

Galileo is of high political importance for the economy and commerce all over Europe as it creates enormous macro-economic benefits.

Standardisation

As Galileo will be implemented in an international environment, it provides a unique opportunity for standardisation and co-operation under European leadership.

Application Industry

Galileo is mandatory as a means of entry for the European equipment industry and service provider to a huge market place which is up to now clearly dominated by US companies.

How is Galileo to be Financed?

The Galileo financing concept of the European Commission

Given the present policy of the US to provide the basic GPS signal free of charge, it would be illusory to imagine that Galileo could be developed and provided exclusively by the private sector. As in a number of major infrastructure projects in the context of the Trans-European Networks, considerable public financing will need to be found. For Galileo, this would apply particularly for the definition and test and validation phases, when basic research, concept testing and development of the space segment would be carried out.

The European Commission and the European Space Agency have therefore set out a three point financing plan:

- substantial financing at the European level, through the EU budget, notably the Transport TEN, and through the ESA GalileoSat programme
- establishment of revenue streams, which is likely to require regulatory action
- developing a public private partnership, to provide complementary finance.

Public sources of funding

More than € 1 billion has already been earmarked in EU and ESA budgets for the Galileo programme in the 2000–2006 period.

Additional sources of funding

- Identification of potential revenue streams to attract the involvement of the private sector in Galileo, which might allow the EIB to finance part of the project.
- A fee on receivers for all satellite based navigation, similar in nature to existing mandatory charges (e.g., for public radio and TV broadcasting).
- Revenues from an integrated, complementary data communications system (payload).



Estimated cost of Galileo

The cost of the space segment and the required ground infrastructure will depend on the ultimately chosen satellite constellation. Some parameters, particularly pending international agreements, need to be frozen before the final design can be determined. However, it is already possible to give a fairly accurate indication of the potential cost of Galileo from work led by ESA and with close involvement of industry. The total cost of Galileo over the period 1999–2008 will be between € 2.2 and 3 billion, depending on the extent of joint operation with GPS and use of terrestrial systems. Within this budget, some € 800 million are allocated for the industrial development of the Galileo space and associated ground control segments.

Recurring costs (operations and replenishment costs corresponding to the options described above) amount to between € 140 million and € 205 million p.a., beginning in 2008. However, some savings should be possible on the cost of the current terrestrial navigation services.



Fundamentals of PPP (Public Private Partnership)

PPP generally involves the private sector participating to a degree in the provision of public services of the sort which have traditionally been supplied by central or local governments. Given the wide range of social and political situations applying across Europe, the partnership takes many forms:

- private operation of publicly owned assets
- private sector build-own-operate (-transfer)
- deferred purchase terms (vendor financing)
- provision of a service to the public as a by-product of a commercial operation

Many PPP schemes are implemented by means of a “Special Purpose Vehicle” company (SPV), founded

by the strategic investors to act as the private partner.

Depending on the service or asset being operated, the private sector may add value by offering its specific skills to the project.

With increasing pressure on public finances, some governments in Europe have been greatly attracted by the private sector funding on terms which are not accounted for as public borrowing.

The provision of a public service may offer incidental opportunities for the private sector to generate additional revenues, thus allowing the private sector to provide a service at less than the full cost of providing this service through a public entity. The public sector may in many cases take a right to share in any additional benefits.

How is Galileo to be Managed?

Galileo is a unique project, involving a wide range of political, economic, security and commercial interests. It will need an organisational structure that reflects this unique character and the implications of the envisaged PPP financing approach. Therefore, a three level management structure is envisaged:

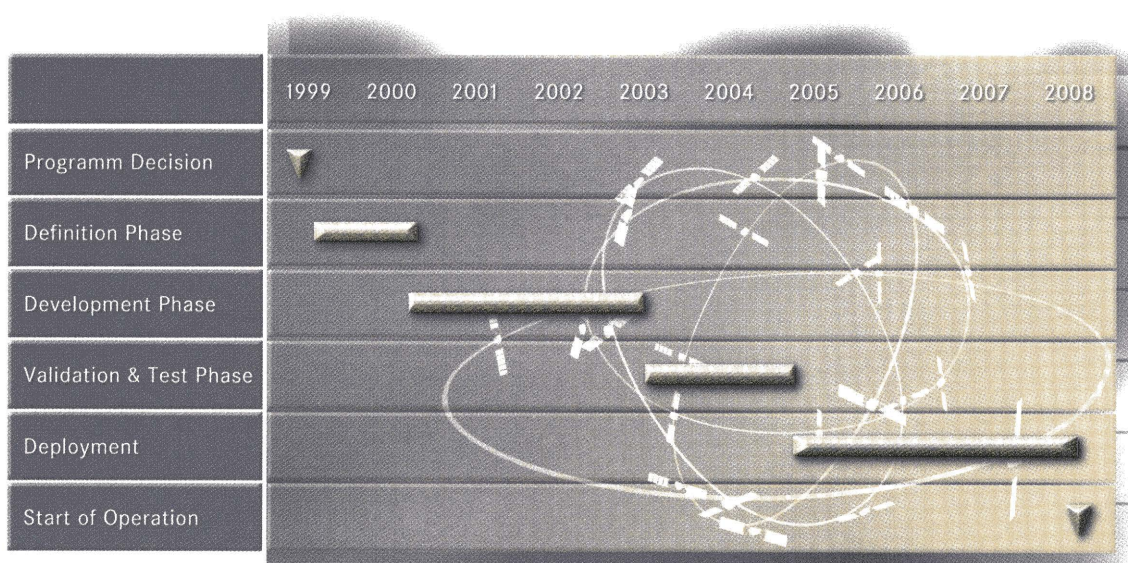
- The political and strategic level, intended to be handled by the EU institutions
- A programme management board, responsible for the conduct of the project, tenders and issue of contracts. It would finally develop into a supervisory role in the operational phase (the Galileo administration).
- The PPP vehicle company, responsible for project delivery and, later on, system operation.

What is the Schedule of Galileo?

According to the current planning, Galileo will be fully operable in 2008 at the latest, with the start of signal transmission in 2005.

As time-to-market is essential for the commercial success of Galileo, the in orbit validation and test programme, which will be performed

by 3 to 5 satellites, will overlap to the serial production and deployment phase of the remaining satellites.



How to Co-operate at International Level?

The European Commission has investigated a number of options for international co-operation for Galileo.



The U.S.A.

There is consensus between the U.S. and Europe that two independent but compatible systems would improve the robustness and possible performance of the overall GNSS (Global Navigation Satellite System) and might potentially allow the use as a sole means of navigation for certain safety-related applications. Such an orientation could have considerable implications for the way Galileo develops and for its cost-effectiveness.

The Russian Federation

The Russian Federation has proposed to the EU a joint approach to develop a state-of-the-art global navigation satellite system. The approach could be based on the transformation of GLONASS into a system under civil control. It would initially be an independent complement to GPS and would gradually evolve into Galileo.

Other countries

Several other countries have indicated interest in co-operating with the EU to obtain benefits from GNSS-1 (EGNOS) and to consider GNSS-2 (Galileo). Contacts in this framework have been made with Central and Eastern European countries, Turkey, Switzerland, Iceland, countries in the CIS, Africa and South America, Canada, Australia, India, Japan, China and Korea. The global acceptance of Galileo and the European approach to GNSS in general should contribute significantly to the commercial success of Galileo.

Galileo is an initiative of the European Commission

GalileoSat is the complementary
development programme of the
European Space Agency



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