European Commission
Directorate-General for
Transport and Energy

Midterm Evaluation of the Galileo project for the period 2002-2004

Final Report

June 2006

COWI

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European Commission, DG TREN

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Executive Summary

Introduction

This *Mid-term evaluation of the Galileo project for the period 2002-2004* concerns the highly complex Galileo project which is Europe's global satellite navigation system. The Galileo project combines technological and organisational innovations with, hopefully, economic, but also political benefits for Europe.

The evaluation is being carried out by COWI A/S, from January 2006 - May 2006, under the existing COWI Service Framework Contract with DG TREN covering Ex Post and Mid Term Evaluations (Ref. TREN/A1/17-2003 Lot 2) for the Directorate-General for Energy and Transport (DG TREN).

Readers should note that the report presents the views of the Consultant, which remain under his responsibility and do not necessarily coincide with those of the Commission.

One project, four phases

The Galileo project is structured into four phases and this evaluation covers the Development and Validation Phase. The evaluation concerns the provisions made by the Community budget (human and financial resources) under its trans-European network budget included in the Multi-annual-Indicative Programme (MIP). It amounts to 550 M€ for the development and validation phase of the Galileo project. However, in order to evaluate this particular phase it is essential to understand the Galileo project in its totality, and parts of the evaluation therefore cover the entire project.

The overall objective

Within the context established through the relevant decisions made by the European Council and the EU Commission in recent years, the objective of the mid-term evaluation is to assess the implementation of the development and validation phase of Galileo during the period 2002-2004. For that purpose, 10 specific evaluation questions have been formulated so that the evaluation themes of effectiveness, efficiency, impact, and sustainability are covered.

Technical description

Accuracy down to metres

Galileo is Europe’s initiative for a state-of-the-art global navigation satellite system, providing a highly accurate, guaranteed global positioning service under civilian control. While providing autonomous navigation and positioning services, Galileo will at the same time be interoperable with GPS (USA) and GLONASS (RUSSIA), the two other global satellite navigation systems. A user

will be able to take a position with the same receiver from any of the satellites in any combination. By offering dual frequencies as a standard, Galileo is, however, expected to deliver real-time positioning accuracy down to the metre range, which is unprecedented for a publicly available system. It will guarantee availability of the service under all but the most extreme circumstances and will inform users within seconds of a failure of any satellite. This will make it suitable for applications where safety is crucial, such as running trains, guiding cars and landing aircraft. The combined use of Galileo and other GNSS systems will offer much improved performances for all types of user communities all over the world.

From open access to restricted access

For several years, work has been carried out on defining the services and the frequency plan. The first version of the technical document defining Galileo's mission (High Level mission Definition - HLD) and, hence, also the range of associated services, was produced at the beginning of 2001. It has been widely distributed and discussed, by both user groups and Member States, and later updated. Galileo is designed to offer several service levels:

- An open, free, basic service, mainly involving applications for the general public and services of general interest. This service is comparable to that provided by civil GPS, but with improved quality and reliability.
- A commercial service facilitating the development of professional applications and offering enhanced performance compared with the basic service, particularly in terms of service guarantee.
- A "vital" service (Safety of Life Service) of a very high quality and integrity for safety-critical applications, such as aviation and shipping.
- A search and rescue service that will greatly improve existing relief and rescue services.
- A public regulated service (PRS), encrypted and resistant to jamming and interference, reserved principally for the public authorities responsible for civil protection, national security and law enforcement which demand a high level of continuity.

The history of Galileo

A long process of decisions

The review of the history of Galileo shows that the project is driven forward within a very complex institutional set-up at two levels: At the level of sponsors and decision makers (European institutions, Member States) and at the level of project management involving in particular ESA, DG TREN and GJU. It shall be noted that the organisational set-up has deviated from phase to phase.

The decision-making process on Galileo consists of a series of decisions that progressively have given legitimacy to still more binding and essential operations. In this way, decision-makers have gained confidence in the project and it has been progressively more difficult for them to withdraw their support.

The following table provides a summary on the history of the Galileo project.

Table 0.1 The Galileo history

Phases	Key achievements
The earlier phase (before 1999)	Council decisions on European involvement in GNSS, in particular the development of EGNOS No firm institutional set-up Financing via research framework contracts
Definition phase (1999-2001)	The Galileo project managed jointly by DG TREN and ESA Creation of Galileo Joint Undertaking Services and system architecture defined
Validation phase (2002 – 2005) (extended till 2008)	GJU as overall manager Several important decisions taking, including decision on and establishment of Supervisory Authority (GSA) GJU, planning of PPP process, international agreements, technical progress, launch of satellites, frequency bands
Deployment phase (2008-2010)	Supervisory authority (GSA) and the Concessionaire will be key actors
Operational phase (2011+)	Supervisory authority (GSA) and the Concessionaire will be key actors

Funding of GNSS

The context: TEN-T

Prior to 2000, there was no specific EU budget line for Global Navigation Satellite Systems. Research, studies and developments related to GNSS were funded through various sources. It was later to become part of the TEN-T funding instrument according to which Community support can be granted to projects of common interest, identified within the framework of the TEN-T Guidelines.

The 2001 MIP (indicatively) earmarked EC contribution totalling 550 M€ to the Galileo project for the period 2001-2006 which corresponds to approx. 20% of the MIP budget for the same period. The total cost of the validation and development phase for the period 2001-2005 was estimated to 1,100 M€.

The EU contribution for the development and validation phase amounted to 550 M€ as follows:

- 2001-EU-1501 A S (30 M€) paid directly to ESA who was the applicant, as the GJU did not exist at that time
- 2001-EU-1501 B (70 M€) ; applied by, paid to and managed by the GJU
- 2002-EU-1501A-S (170 M€) ; idem
- 2003-EU-1501-S (80 M€) ; idem
- 2004-EU-1501A-S (100 M€); idem

Two additional decisions were made in 2005 and 2006 (100 M€) bringing the total EU contribution to the development and validation phase to 550 M€.

Based on revised costs estimates made by ESA, and confirmed by GJU, the Commission acknowledged in early 2005 that the development and validation phase would cost up to 400 M€ more than foreseen, cf. table below.

Table 0.2 Overview of cost increases

Phases	Estimates till 2004 (M€)	Current estimates (M€)
Development and validation phase (2001-2005)	1,100	1,500
Deployment phase (2006-2007)	2,100	2,100
Total	3,200	3,600
Maximum TEN-T support (20%)	640	720

Total costs

Following the integration of EGNOS and Galileo, the total cost investment for the development and deployment of the European GNSS programme is estimated to reach 4,216 M€ (616+3,600) for which the EU TEN-T contribution over the 2001-2006 period would amount to 823 M€ (143+680) which corresponds to a level of co-financing of 19.5 %.

Evaluations results

This *Mid-term evaluation of the Galileo project for the period 2002-2004* has had the aim of evaluating the implementation of the development and validation phase of Galileo during the period 2002-2004. In order to do so, it has been necessary to acquire a broader understanding of the entire Galileo project, and parts of the evaluation therefore cover the entire project.

The evaluation is organised so as to answer ten specific evaluation questions that were established in the inception phase of the evaluation. The conclusions in this chapter answer these questions and the chapter also provides a broader reflection on the evaluation results.

On effectiveness

The objectives

Evaluation question 1: What are the objectives of Galileo, and in particular the objectives of the development and validation phase?

The overall objective of the Galileo project is to establish a global navigation satellite system based on the following principles: primarily for civilian use, offering a broad range of services, being a significant quality-improvement compared to the GPS-system, and should involve public-private partnerships. The Galileo project is motivated by political, economic and technological potentials that in total create a richly faceted argumentation which many different actors can accept.

Level of goal-fulfilment

Evaluation question 2: To what extent have the objectives of the development and validation phase been met?

The level of goal fulfilment of the Development and Validation phase is, overall, high. Three out of four tasks (USA-agreement, service definition, and future regulatory structures) are successfully completed while the public-private partnership, being the fourth task, is not yet completed. Significant progress is being made in negotiating terms with the Merged Consortium but conclusions on risk allocation have not yet been achieved.

International agreements

Evaluation question 3: How effective has the process of concluding international agreements been, and what factors explain that it has been possible to conclude several important agreements in a relative short period of time?

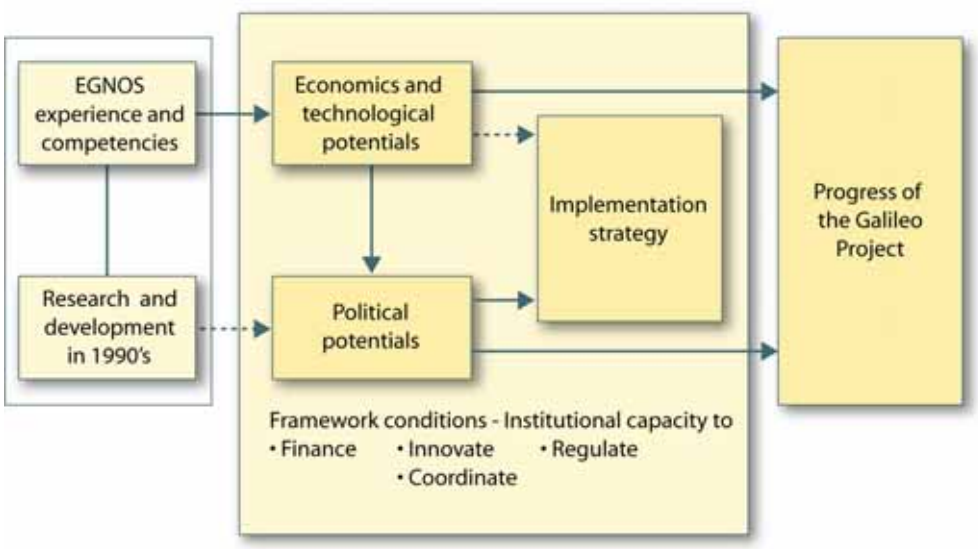
The process of concluding international agreements has been successful as several countries are committing themselves to be future users of Galileo. For the EU it was particularly important to secure third country agreements, Galileo being a new system introduced. Market access and definition of standards are crucial. The interest of third countries has also been sparked by the potential of developing high tech navigation research and industry including the potential creation of jobs. To facilitate international agreements, the EU established a framework for negotiations comprising criteria and priorities for negotiation and an overall content of agreement

Explaining the progress

Evaluation question 4: Which factors explain the successful implementation of the development phase in terms of commitment, delivery and progress?

A combination of factors has been decisive in moving the Galileo project from idea to plan to reality, cf. the figure below.

Figure 0.1 Explaining the progress of Galileo project



In particular, the political and economic potentials of the Galileo project have been important drivers. As these potentials became still more documented and accepted it was of crucial importance to develop an effective implementation strategy. The strategy was prepared and applied and became thereafter a factor in it self of importance for progress. The above-mentioned factors were effective because of the institutional framework which provided finance, regulation, innovation and coordination.

On efficiency

The GJU model

Evaluation question 5: Has the GJU, as a particular organisational structure, been efficient in the management of the development phase?

As noted in relevant EU Commission Communications and articles on Galileo and also orally expressed by experts interviewed for this evaluation, the Galileo project is a special project in terms of technological, political and institutional complexity. The project execution is therefore requiring effective coordination and cooperation between the key actors involved; DG TREN, ESA, and the Galileo Joint Undertaking (GJU). The GJU was set-up by EU and ESA as a new organisational concept to run the everyday project implementation of the development and validation phase. As a particular structure - with the following characteristics: i) temporary, ii) management body, iii) complexity-reduction - the GJU has been efficient in the management of the Development and Validation phase. The model is now being used in other contexts.

Efficiency of GJU

Evaluation question 6: Has the GJU been efficient in meeting its specific objectives?

6.1 In overseeing the establishment of a PPP?

At an early stage it was decided by the Transport Council to establish a public-private partnership with a private concessionaire to manage the Galileo system. Measured against 'ideal' criteria for PPP processes, the process of selecting the concessionaire has been partly successful. Due to the limited number of provid-

ers of the necessary technology in Europe and the difficulties of forecasting revenues, full competition could not be sustained until contract close. Accordingly *negotiated procedure* was recommended for the procurement of the concession. Risk allocation is still unclear at this late stage of contract negotiation. The GJU did not develop a Public Sector Comparator until late in the process.

6.2. In preparing first series of satellites to test reliability of Galileo system?

A series of satellites were launched to finalise the technological developments and to ensure the large scale demonstration of capabilities and reliability of the system. The role of GJU was to conclude an agreement with ESA who will carry out the activities and furthermore to administrate and carry out financial control. Thus the overall aims of the development and in orbit validation phase has been achieved or are on track, despite political difficulties and requirements of design changes. Overall GJU is credited for its part in this process on administration and financial control, however, this task alone would probably not justify setting up a joint undertaking.

6.3 In management of projects under the EU's 6th Framework Programme?

The 6FP contributions were meant to develop the user segment of Galilleo. The task of administrative and financial management of the whole cycle of the calls for proposals was entrusted to GJU. Over a 4 year period, the GJU has been preparing, launching, selecting, managing and monitoring 3 calls for proposal resulting in a total expected co-financing of 110 Million Euro. Selected activities of the first call are almost completed and all activities of the second acc are on-going. User applications and receivers have been developed opening potential private sector opportunities for EGNOS and Galileo. The same activities could have been done internally in DG TREN but the fact that the 6FP activities have been managed and technically monitored by dedicated and specialised GNSS experts within the GJU contributed to the efficient and timely achievement of this task.

6.4 In managing the integration of EGNOS into Galileo?

It is found to be correct to entrust the administrative and financial management of EU contributions to EGNOS to the GJU when the EU decided to integrate EGNOS into Galileo due to the skills and experience available within the GJU. The GJU acted efficiently as it initiated and carried out all the tasks requested by the Council. Most of them are still on-going but achievements are expected in a year or 2.

Level of cost overrun

Evaluation question 7: What is the level of cost overrun of the development and validation phase?

The cost of the development and validation phase increased from 1,100 M€ to 1,500 M€ (37%) in the course of implementation due to design changes, delays and cost increases. According to conventional planning practices, the level of cost overrun is very low as the cost increase mostly can be explained with reference to events occurring outside of the project. The cost increase can also be

interpreted according to the 'optimism bias' school of planning leading to the conclusion that the cost increase of 402 M€ should be seen as a cost overrun.

Since project launch, the budgeted cost of the entire Galileo project has been relatively constant. Currently, the development and deployment cost of GNSS - covering EGNOS (616 M€) and Galileo (3,600 M€) - is expected to amount to 4,216 M€ for which the EU TEN-T contribution over the 2001-2006 period will amount to 823 M€. However, ultimately, the EU contribution to the Galileo project will depend also on the outcome of the concession agreement negotiations for which there is still no conclusion.

Comparing with GPS?

A preliminary comparison of the development costs of Galileo with GPS development costs was initiated as part of the evaluation; however with the results that a comparison for a variety of reasons cannot be undertaken in a meaningful manner within the scope of the evaluation. The GPS system, being the first satellite navigation system to be developed, was significantly more costly to develop than the Galileo system but it includes also several military components.

On impact

Impact

Evaluation question 8: What will be the likely impact of Galileo and in particular the impact of the development and validation phase?

A judgement on the impact of the Galileo project can be given only after the system has been in operation for a few years. Some initial impacts can be observed; the most significant one being the impact of the Joint Undertaking organisational model.

On sustainability

Sustainability

Evaluation question 9: To what extent will the results generated in the Development and Validation phase be used in the subsequent phase?

The sustainability of the main achievements of the Development and Validation phase is high, with the exemption that the result of the PPP process in unknown.

On consistency

Consistency

Evaluation question 10: To what extent is the Galileo project consistent with other key EU policies?

Galileo is found to be consistent with other main EU policies e.g. the Lisbon Strategy and Sustainable Development strategies and being integral part of both Transport Policy and a pillar of European Space Policy. It is premature to measure the final outcome and impact of Galileo on the other policies as it will first be operational by 2010 however for each policy area indicators have been proposed based on Strategies and White Papers.

Recommendation

In the light of the evaluation findings, the following recommendations have been made for consideration in the future implementation of the Galileo project and related projects:

- **Lessons learned.** It is concluded that the progress of the Galileo project has been good, and that the progress is due to, among other factors, the implementation strategy applied. It should be considered how to make best use of the experience gained by planning and implementing the Galileo project. The experience of the Galileo planning process might useful to consider in the preparation of the large technological and growth initiatives wherein Europe wants to have a leading role in the near future (SESAR, ITER….).
- **Reference forecasting**. Mega-projects are notoriously difficult to budget. Although the Galileo project has been relatively successful in that respect, it should nevertheless be considered to apply reference forecasting for projects of a similar character to avoid cost overrun. Also other methods that are developed in the wake of recent years' increasing focus on optimism bias in mega-projects planning can be suggested.
- **Monitor consistency with EU policies.** It is suggested to establish indicator and collect statistics at EU level (if not already available) to measure the impact of Galileo once operational particularly related to turnover and employment in Galileo related industries and markets etc.
- **PPP**. It is recommend to enhance the supervision of the concession process in the final stages to ensure fair conditions for the public sector (and perhaps private) given that there is only one concessionaire left.
- **Homepages and access to information.** The Galileo homepages hosted by DG TREN, GJU and ESA provides a wealth of useful information on the Galileo project targeted at a wide audience. It is recommended to update the homepages as follows:
  - *The DG TREN homepage*
    - provide an updated time schedule (avoiding statements like 'GALILEO will be fully operable in 2008 at the latest')
    - make explicit statements and explanations on satellite navigation systems and privacy concerns, e.g. likelihood of the Galileo system to be misused, thereby adding to the legitimacy of the system
  - *The GJU homepage*
    - provide more information on the costs and budgets (easy to understand breakdown of budgets)
    - make progress reporting to the Commission available.
- **Keeping the momentum.** Taking into account the experience gained by the GJU and the progresses made to date, it appears important to achieve a smooth transfer of GJU activities to a GSA with adequate staffing and budget.

1 Introduction

1.1 Foreword

Introduction

This *Mid-term evaluation of the Galileo project for the period 2002-2004* concerns the highly complex Galileo project which is Europe's global satellite navigation system. The Galileo project combines technological and organisational innovations with, hopefully, economic, but also political benefits for Europe.

The evaluation is carried out by COWI A/S under the existing COWI Service Framework Contract with DG TREN covering Ex Post and Mid Term Evaluations (Ref. TREN/A1/17-2003 Lot 2) for the Directorate-General for Energy and Transport (DG TREN).

Readers should note that the report presents the views of the Consultant, which remain under his responsibility and do not necessarily coincide with those of the Commission.

Scope

In compliance with the requirements of the EU Financial Regulation, DG TREN has requested the present Mid-Term Evaluation through its dedicated framework contract. The evaluation concerns the provisions made by the Community budget (human and financial resources) under its trans-European network budget included in the Multi-annual-Indicative Programme (MIP). This amounts to 550 M€ as follows:

- 2001-EU-1501 A S (30 M€) paid to ESA (GJU did not exist at that time)
- 2001-EU-1501 B (70 M€) ; applied by, paid to and managed by the GJU
- 2002-EU-1501A-S (170 M€) ; idem
- 2003-EU-1501-S (80 M€) ; idem
- 2004-EU-1501A-S (100 M€); idem

Two additional Decisions were taken in 2005 and 2006 for a total of 100 M€ (76+24) to support the estimated cost of the validation and development phase, bringing the total EU contribution to the Development and Validation phase to 550 M€.

One project, four phases

The Galileo project is structured into four phases and this evaluation covers the Development and Validation Phase. However, in order to evaluate this

particular phase it is essential to understand the Galileo project in its totality, and parts of the evaluation therefore cover the entire project.

1.2 Objectives and scope of evaluation

The overall objective

Within the context established through the relevant decisions made by the European Council and the EU Commission in recent years, the objective of the mid-term evaluation is to assess the implementation of the development and validation phase of Galileo during the period 2002-2004.

Specific evaluation questions

For that purpose, specific evaluation questions have been formulated so that the evaluation themes on effectiveness, efficiency, impact, and sustainability are covered.

The *effectiveness* of the Development and Validation Phase is analysed via a description of the objectives relating to that particular phase and the level of goal fulfilment. It also includes an analysis of factors that may explain the apparent successful implementation of the Development and Validation Phase in terms of commitment, delivery and progress. A judgement on *efficiency* is made on the basis of a review of the organisational structure of Galileo Joint Undertaking (GJU), and an analysis on how efficiently GJU has been in meeting its specific objectives which includes the establishment of a public private partnership to manage the Galileo Programme. Information is provided on the overall efficiency of the planning process by analysing the level of cost overrun and a preliminary comparison with the US GPS system is also included.

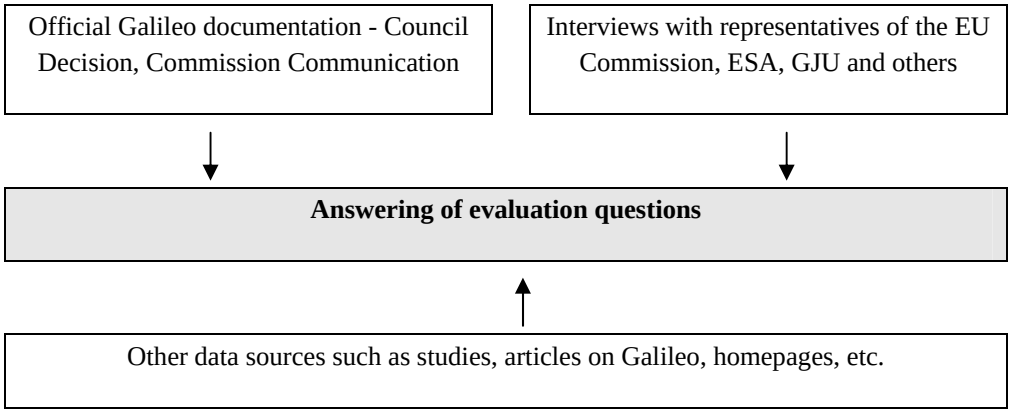
Finally, a list of the initial *impacts* of Galileo is presented and the *sustainability* of the achievements is also assessed. Being a Midterm Evaluation however, it is natural that the evaluation questions related to effectiveness and efficiency are more fully covered than questions on sustainability and impact which only can be covered, in depth, some time after completion of a project (which is not the case with the Galileo project). The evaluation questions are specified throughout the report as the report is structured on the basis of the evaluation themes.

1.3 Methodology

Data sources

As to evaluation methodology, two aspects should be noted. Firstly, the conclusions and judgements are based on varied but complementary data sources cf. the figure below. The evaluation modality has, thus, been to scan relevant literature in order to form preliminary hypotheses and observations which subsequently have been qualified via interviews with selected experts. See Appendix 1 for a list of experts interviewed.

Figure 1.1 Sources of information contributing to the mid-term evaluation



An important source of information has been the Official Galileo Documentations comprising among more numerous Council decisions and Commission Communications also reflecting the ongoing and continuous involvement of the Member States and the European Parliament and various Directorate Generals throughout the Galileo project. A full list of Council Decisions and Commission Communications are presented in Appendix 2.

Secondly, while most of the evaluation questions can be clearly answered our judgements are, in some cases, less definitive, reflecting the fact that some of the evaluation questions due to the uniqueness of the Galileo project cannot be answered via traditional benchmarks. There is, for instance, no yardstick by which to measure the relationship between input (money, staff) with output (the system) and it was therefore necessary to develop other approaches when making judgements. All evaluation questions, data sources and the used benchmarks are listed in Appendix 3.

Structure of the report

The remainder of this report provides the preliminary results of the evaluation. Chapter 2 gives an overview of the content, history and funding of the Galileo project. Chapters 3-5 cover the evaluation theme of effectiveness, efficiency, sustainability and impact. The conclusions and recommendations are given in Chapter 6 and Chapter 7.

2 The Galileo project

Purpose of chapter

This chapter describes the context of the evaluation, i.e. provides basic information on Galileo, the history of the project, the main stakeholders involved, and the funding of the project. It does not address any of the evaluation questions directly but sets the scene for the subsequent answering of the evaluation questions.

2.1 What is Galileo[1]

Improve quality and increase the number of applications

The vast majority of satellite navigation applications are currently based on GPS performances, and great technological effort is spent in integrating satellite-derived information with numerous other techniques, in order to reach better positioning precision with improved reliability. In 2011, the global satellite navigation system (GNSS) infrastructure will, with the advent of Galileo, double its present capacity. The availability of two or more constellations, more than doubling the total number of available satellites in orbit, will enhance the quality of the services, increasing the number of potential users and applications.

2.1.1 Technical description

Accuracy down to metres

Galileo is Europe's initiative for a state-of-the-art global navigation satellite system, providing a highly accurate, guaranteed global positioning service under civilian control. While providing autonomous navigation and positioning services, Galileo will at the same time be interoperable with GPS (USA) and GLONASS (RUSSIA), the two other global satellite navigation systems. A user will be able to take a position with the same receiver from any of the satellites in any combination. By offering dual frequencies as standard, Galileo is, however, expected to deliver real-time positioning accuracy down to the metre range, which is unprecedented for a publicly available system. It will guarantee availability of the service under all but the most extreme circumstances and will inform users within seconds of a failure of any satellite. This will make it suitable for applications where safety is crucial, such as running trains, guiding cars and landing aircraft. The combined use of Galileo and other GNSS systems

[1] The description of the technical aspects of the Galileo project in this chapter is borrowed from various formal sources of information, such as the DG TREN and GJU homepages.

will offer much improved performances for all types of user communities all over the world.

The main components

The fully deployed Galileo system will consist of 30 satellites and the associated ground infrastructure. The architecture is made up of four principal components:

- Global component
- Regional components
- Local components
- User receivers and terminals

Global component

The central component will be the global constellation of thirty satellites, distributed over three planes in Medium Earth Orbit (MEO). Within each plane, one satellite is an active spare, able to be moved to any of the other satellite positions within its plane, for replacement of a failed satellite.

Several constellations were studied for optimisation of the space segment. The retained constellation is based exclusively on satellites in MEO orbit, which ensures a uniform performance in terms of accuracy and availability. The Galileo satellite constellation is, furthermore, well suited for high latitude countries and offers an improved visibility in towns and cities.

The control of the satellite constellation, the synchronization of the satellite atomic clocks, processing of the integrity signal, and data handling of all internal and external elements is performed by two redundant Galileo Control Centers (GCC). Both of which will be located on European ground.

Regional components

The design of the Galileo system permits the introduction of data from regional service providers using authorised integrity up-link channels provided by Galileo, 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.

Local components

The Galileo system will provide high level 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: 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.

User receivers and terminals

Receivers will be the crucial link in the Galileo chain and will need to satisfy market requirements such as competitive performance and costs compared with the existing systems and adequate tailoring to the needs of users.

A wide range of Galileo receivers will be available, providing the various types of satellite radio navigation services on offer, many combined with additional functions. In addition, technological potential will lead to a high degree of integration of these functions (standard 'microchips' tailored to a specific function). The challenge of the market in Galileo receivers represents one of the major factors which will determine whether or not the European industry successfully takes off in this area.

2.1.2 The five services

From open access to restricted access of various levels

For several years, work has been carried out on defining the services and the frequency plan. The first version of the technical document defining Galileo's mission (High Level mission Definition - HLD) and, hence, also the range of associated services, was produced at the beginning of 2001. It has been widely distributed and discussed, by both user groups and Member States, and later updated. Galileo is designed to offer several service levels:

- An open, free, basic service, mainly involving applications for the general public and services of general interest. This service is comparable to that provided by civil GPS, but with improved quality and reliability.
- A commercial service facilitating the development of professional applications and offering enhanced performance compared with the basic service, particularly in terms of service guarantee.
- A "vital" service (Safety of Life Service) of a very high quality and integrity for safety-critical applications, such as aviation and shipping.
- A search and rescue service that will greatly improve existing relief and rescue services.
- A public regulated service (PRS), encrypted and resistant to jamming and interference, reserved principally for the public authorities responsible for civil protection, national security and law enforcement which demand a high level of continuity.

2.1.3 Applications

A myriad of applications

It has been said that Galileo will offer everybody, everywhere, satellite positioning services with guaranteed reliability. Individuals, companies and administrations will all be able to benefit, whether on the road, railways, in the sky or at sea: hikers will be able to find their way, and tourists will be able to find the museum or restaurant they are looking for, and taxi drivers will arrive at the correct destination. Examples of applications include transport (ITS, aviation, onboard maritime navigation), energy, banking (better encryption

system), agriculture (precision farming), fishing (monitoring of fish stocks), and recreation (new forms of communication).[2]

2.2 An overview of the history of Galileo

This section traces key developments and decisions since the late 1990's thereby providing an understanding of the progression of the project. The description follows the breakdown of the project into the 'traditional' Galileo project phases namely definition phase, development and validation phase, the deployment phase, and the operational phase.

2.2.1 The early phase (before 1999)[3]

Initiative in 1994

The first political initiative came in 1994 when the European Commission launched a proposal for Europe to engage in satellite navigation (COM (94) 248); an initiative that prepared the ground for the development of the first generation of Global Navigation Satellite System, called EGNOS,[4] which was indented to give Europe the experience it needed to launch a second generation satellite system: the Galileo project, as it was termed in early 1999.

In this early phase, before a firm commitment was obtained from the involved institutions and EU Member States, much attention was given to document the potentials of the Galileo project and to secure support of the concept. This is evident from reading through the Communications of that time. As an example, with reference to US dominance in GPS, the EU Commission stated that 'an urgent decision is needed' and that 'unless Europe gives a firm political commitment now to developing a European system, to be in place at the same time as the next generation of GPS, it will simply be too late' (COM(1999) 54 final, p iv).

No firm institutional set-up

In the early phase, Galileo was largely a research and development oriented programme without a broader institutional set-up and funding was primarily allocated via framework research programmes. It was however, at an early stage, recognised that the European Commission was not in a position to be an operator of Galileo, while its role as a regulatory authority was widely discussed by the EU Member States (Lembke, 2001).

The emergence of satellite navigation was largely the result of a confluence of activities undertaken by three European organisations: ESA (The European

[2] An overview of the applications of the Galileo system is given at the DG TREN home-page http://europa.eu.int/comm/dgs/energy_transport/Galileo/applications/index_en.htm

[3] The description in this section borrows significantly from the article '*The Politics of Galileo'*, 2001, Johan Lembke, Visiting Center Associate, European Union Center, Center for West European Studies, European Policy Paper No. 7.

[4] EGNOS is a satellite radio navigation system that relies on the US GPS and the Russian GLONASS and monitors their integrity, thereby warning the user in a very shorts pace of time of any malfunction that could affect the quality of the signal relayed by geostationary satellites.

Space Agency), Eurocontrol (the organisation responsible for coordination air traffic control) and DG TREN. Also, it should be noted that the world civil aviation community influenced the process by clearly indicating its interest in using satellite-based navigation aids for purposes such as enabling aircraft to land in bad weather, depending exclusively on satellite navigation.

In sum, the project paved its way towards the political agenda in this early phase. The key achievements were the increased commitment among the future sponsors and the increasing understanding of the rational of Galileo. At the technical level, several studies were undertaken to provide information as to the definition of the system design; efforts that were greatly expanded in the subsequent definition phase.

2.2.2 The definition phase (1999 - 2000)

Key decision taken in 1999

The Galileo project has been formed by a number of decisions each of which gave the project another push forward and provided legitimacy. In June 1999, the EU Transport Council for instance, decided that the EU should embark on the Galileo definition phase; a key decision which meant that the EU could move ahead with plans to build its own global satellite navigation system but the decision did not represent a major financial commitment. Instead, the Commission has provided an important financial contribution to the definition phase through the 5th Framework Programme for Research and Development.

During the definition phase, the Commission and ESA mobilised a 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 definition phase made it possible to define the first version of the Mission High Level Definition; a document that was largely distributed and commented on by users' groups and member states. A final version of the document was presented in the September 2002. A number of projects and studies contributed to the definition phase cf. the text box below.

Text box 1 Studies and projects launched in the Definition phase

- GALA for the overall architecture definition
- GEMINUS to support the Galileo service definition
- INTEG for EGNOS (European Geostationary Overlay Service) integration into Galileo
- SAGA to support the Galileo Standardisation process
- GalileoSat for the space segment architecture definition
- GUST related to Galileo receivers pre-specification and certification
- SARGAL related to potential SAR (Search and Rescue) applications of Galileo.
- Based on the outcome of the definition Phase, the Galileo Mission High Level Definition document was produced and consolidated through a consultation process, involving Members States, users and potential private investors. It presents a picture of the main characteristics and performance of the Galileo Mission.
- Two major activities have consolidated the definition of the Galileo system:
- Phase B2 of the GalileoSat study led by ESA focussed on the consolidation of

mission and system requirements, system architecture and finalisation of phase B activities leading to the Preliminary System Design Review (PSDR).
- The Community-funded GALILEI project defined the overall service and user approach for Galileo, complementing the studies performed by ESA in the frame of the Galileo definition phase.

Institutional set-up: Towards a firmer structure

The institutional structure of the Galileo project was a matter of much consideration. It was often stated in Communications and Council decisions that Galileo, as a unique project, required a set-up that reflected this uniqueness, and effort was devoted to finding the right long-term set-up. However, until the right model could be agreed upon, the Galileo programme's management was shared between the Commission and ESA, each of whom managed a certain number of contracts intended to complete the programme's definition phase in accordance with their own administrative and budgetary rules. One particular consequence of this was that the Commission and ESA referred to two different 'steering committees'; the first consisting of the Member States of the European Union and the second of the Member States[5] of ESA which is broader than the former (COM (2000) 750 final).

For lack of a better structure, a Programme Management Board, made up of representatives of the Commission and ESA, sought to secure coordination. It also attempted to compile the results of the many activities and to draw up coordinated plans for the future. In view of the increasing complexity, it was nevertheless recognised that a firmer institutional set-up was required. It was therefore proposed to establish a structure with an organisation having a certain amount of legal and financial independence and being the contracting authority for Galileo (latter to become the Galileo Joint Undertaking).

Other achievements in this phase were the investigation of the cost-benefit ratio of Galileo which was concluded to be promising and a decision was made on the involvement of the private sector in Public-Private-Partnership. See Section 4.2.1 for an analysis of this process.

2.2.3 The development and validation phase (2002-2008)

The development and validation phase (2002 – 2008) covers the detailed definition and subsequent manufacture of the various system components: satellites, ground components and user receivers. This validation required sending into orbit prototype satellites as from 2005 and the creation of a terrestrial infrastructure.

Division of work between EU and ESA

Historically, ESA has had little to do with the EU but in this phase ESA and EU worked closely together. The overall division of work was as follows: The EU was responsible for the political dimension and the high-level mission

[5] ESA's 17 members are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

requirements and initiated studies on e.g. the overall architecture, the economic benefits and the user needs. These include the GALILEI studies that address the local architectures, interoperability and signals and frequencies. Moreover, they provide a market observatory and cater for investigations into legal, institutional, standardisation, certification and regulatory issues.

ESA's responsibility covers the definition, development, and in-orbit validation of the space segment and related ground element. Work on new technologies needed for the constellation and the ground segment has continued at ESA's technical centre, ESTEC in the Netherlands since a number of years already. These critical technologies include the development of high precision clocks to be installed on-board the satellites (applying rubidium and passive hydrogen maser frequency standards), on-board timing units for steering the individual clocks to a common Galileo System Time, signal generators to produce the positioning signals that the Galileo spacecraft will broadcast; power amplifiers, radio-frequency multiplexers and antennas and telecommand & telemetry transponders.

Creation of Galileo Joint Undertaking

The Regulation setting up the Galileo Joint Undertaking was adopted in May 2002 (Council Regulation no 876/2002). Most of the Development and Validation phase was thus managed by the Galileo Joint Undertaking which became fully operational mid 2003.

The two main missions of the Joint Undertaking are to preside over the implementation of the development phase and to prepare the subsequent stages of Galileo. The Joint Undertaking prepared the structures designed to ensure the management of the deployment and operation phases and determined the conditions for financial participation by the private sector (in progress). The organs of the Joint Undertaking are the Administrative Board (representatives of the members), the Executive Committee and the Director. The seat of the Joint Undertaking is Brussels. The founder members of the Joint Undertaking are the European Community and the European Investment Bank. See chapter 4 for an analysis of GJU as a particular organisation model.

Actors involved

The table below summaries the role of the public authorities involved with the Development and Validation phase.

Table 2.1 Role of public authorities' involved

• GJU	• ESA	• DG-TREN
• Oversees the establishment of PPP • Supervises the activities of the development and validation phase • Provides technical management to projects under the EU's 6th Framework Programme for Research and Development • Manages the integration of EGNOS into Galileo	• Implementation of In-Orbit validation process • Launch of the first series of satellites for the large-scale demonstration of the reliability of Galileo system • Development and testing of ground segment	• Initiate studies covering market, legal and technical studies. • Oversee the progress of the project • The overall funding programmes. • Presentations at political level

Funding

The European Commission had some difficulty trying to secure funding for this stage of the Galileo project. European Member States were wary of investing the necessary funds but, in late 2002, all EU MS became strongly in favour of Galileo, and as a result the project received sufficient funding. In March 2002, EU and ESA agreed to fund the project during this phase with an allocation of 1,100 M€, each allocating 550 M€.

Considerable progress

Recent progress reporting from the Commission (COM (2004) 112 final, COM (2004) 636 final) clearly indicates the progression of the project, using expressions like 'the development phase is at a very advanced stage', advances 'have been considerable' and 'the programme is evolving as planned'. It is furthermore clearly said that all the conditions set by the Council for moving to the deployment phase have been met. But, it was also noted that confirmation is necessary in order to enable the GJU to complete the negotiation of the concession contract in the course of 2006 and to enable private-sector stakeholders to confirm their bids and financial commitments. As this has not yet been possible, the Development and Validation phase is prolonged to last till 2008. For a description of the level of goal fulfilment of this phase, see section 3.2.

2.2.4 The deployment phase (2008-2010)

The deployment phase will consist in gradually putting all the operational satellites into orbit from 2006 and in ensuring the full deployment of the ground infrastructure so as to be able to begin providing services as from 2008 and being fully operational from 2011 onwards.

European GNSS Supervisory Authority

The institutional complexity of the Galileo project is repeatedly stressed in various analysis and Communications and also the deployment phase will see a new set-up: The European GNSS Supervisory Authority (GSA) was established by a Council conclusion of 12 July 2004. The rationale of the establishment rests with the need to ensure that essential public interests in this field are adequately defended and represented. The structure is modelled on that of a regulatory agency and external to the Commission. It completes the institutional framework for European satellite radio navigation, and 'it signals the Union's political will to implement the Galileo programme successfully and make it definitive', as stated in COM (2004) 112 final.

The Authority has been entrusted with the responsibility of:

- Managing the European satellite navigation programmes (such as Galileo and EGNOS) and controlling the use of the funds allocated to them;
- Being the licensing authority vis-à-vis the private concession holder responsible for implementing and managing the Galileo deployment and operation phases and ensuring that the concession holder complies with the concession contract;
- All matters related to the right to use the frequencies necessary to the operation of the systems, to the certification of the components of the systems and to the systems' safety and security;
- Being the owner of all the tangible and intangible assets created or developed under the Galileo and EGNOS programmes;
- Assisting the Commission in matters involving satellite radio-navigation, particularly in cases where legislative and regulatory measures prove necessary.

The GSA is to be a Community agency located in one of the Member States of the European Union. Until the final decision on location is taken, the Authority will be provisionally located in Brussels.

Furthermore, a *Centre for Security and Safety* is to be established. Since the start of the work on Galileo, matters connected with security of the system were the subject of studies by two bodies, namely the Galileo System Security Board under coordination by the European Commission and the Galileo Security Advisory Board set up by the European Space Agency. It is foreseen that the new Centre of Security and Safety will be placed under the direct responsibility of the General Secretary of the Council/High Representative for the Common Security and Foreign Policy.

Financing

The costs of the deployment phase is expected to be €2.1 billion which should be borne mainly by the future system concessionaire (€1.4 billion). The Transport Council has recommended that Community funding should not exceed one third of the total financing of the deployment phase.

2.2.5 The operational phase (2011 onwards)

In 2011, the Galileo project will be fully operational and the project - which at that time will be an operation rather than 'project' will be run by the concessionaire and with the European GNSS Supervisory Authority (GSA) being the main public actor.

2.2.6 Summary

The table below is a summary of the history of the Galileo project.

Table 2.2 Matrix showing Galileo history

	Institutional set-up	Key decisions	Main actors	Key achievements
The earlier phase (before 1999)	No firm set-up. Financing via research framework contracts	Initial 'go' decisions (1994 and 1999)	DG TREN, ESA, Euro-control, aviation community	EGNOS development Increased commitments Preliminary definition
Definition phase (1999-2001)	DG TREN and ESA plus coordination via Programme Management Board	Creation of GJU	DG TREN, ESA, space industry	Socio-economic validation Services and system architecture defined
Validation phase (2002 – 2008)	GJU as overall manager	Several decisions, including decision and establishment of Supervisory Authority (GSA)	DG TREN, GJU ESA, space industry	GJU, planning of PPP process, international agreements, technical progress, launch of satellites, frequency bands
Deployment phase (2008-2010)	Supervisory authority (GSA) Concessionaire		Supervisory authority (GSA) Concessionaire	
Operational phase (2011+)	Supervisory authority (GSA) Concessionaire		Supervisory authority (GSA) Concessionaire	

Emerging issues

The overview gives rise to the following observations, most of which will be covered in detail in later sections of the report:

- Firstly, Galileo appears to be a success (according to the progress reporting by the Commission) but delays in the concession process have been noted.

- The Galileo project is driven forward within a very complex institutional set-up at two levels: At the level of sponsors and decision makers (European institutions, Member States) and at the level of project management involving in particular ESA, DG TREN and GJU. It has been noted that the organisational set-up has deviated from phase to phase.

- Finally, it is observed that the decision-making process on Galileo really is - a process. Rather than speaking of *one* decision to launch Galileo it is accurate to talk of a series of decisions that progressively have given legitimacy to still more binding and essential operations. It that way decision-makers have gained confidence in the project and it has been progressively more difficult for them to withdraw their support.

2.3 Funding of GNSS

The context: TEN-T

The involvement of the Commission and particularly DG TREN in the Satellite positioning was stated already in 1992 following a study that confirmed the need for Europe to be active in this sector. Prior to 2000, there was not a specific EU budget line for Global Navigation Satellite Systems. Research, studies and developments related to GNSS were funded through various sources such as 5th and 6th Framework Programme for Research and Development.

It was later to become part of the TEN-T funding instrument according to which Community support can be granted to projects of common interest, identified within the framework of the TEN-T Guidelines. The TEN-T budgetary resources allocated by the Commission for the 2000-2006 period amounted to 4.6 billion EURO of which 4.17 billion are earmarked for Transport. The levels of project support are decided to be maximum 50% of the total study cost and up to 10% of total investment cost of projects. However, Community aid can possibly reach 20% of total investment in the case of, exactly, the Galileo system and cross-border sections of the Priority Projects started before 2010.

Since 2001, Galileo is funded through the MIP[6] while EGNOS is funded through annual commitments (non-MIP budget). In 2003, the Commission proposed to integrate EGNOS into the Galileo Programme[7].

[6] The purpose of the multi-annual indicative programme (MIP) is to give a clear indication of planned spending on major projects so that a certain level of funding will be provided by the Community throughout the implementation phase of the projects and to give a sufficient incentive and guarantee to potential investors. The Regulation on MIP (2001, 2654 final of 19/0/2001) also introduces the Commission's willingness to promote the recourse to private sources of funding and PPP initiatives in TEN-T projects. The MIP Decision of 2001 included the Galileo project with 550 M€.

[7] COM(2003) 123 final dated 19/3/2003

The cost of EGNOS (GNSS 1)

The EGNOS system has been developed by ESA and Eurocontrol with financial support from the Commission.

The total cost of development of EGNOS was estimated at the level of 310 M€ up to end 2003. The total TEN-T EC contributions between 1995 and 2003 to EGNOS amounted to 116.4 M€.

The Community support to EGNOS (from TEN-T) over the period 1995-2004 amounted 130.4 M€ to which should be added 10 M€ requested from the 2005 annual budget[8].

Since 2002 the GJU, being responsible for the integration of EGNOS into Galileo, submits annual applications for TEN-T financial interventions for EGNOS and implements the Commission Decisions.

The EGNOS system is in validation phase in order to achive its OQR[9] phase in March 2007. The total cost of EGNOS is now expected to amount around 616 M€[10] for the period 1995-2006. EC TEN-T contributions for the same period have been updated and will amount a maximum of 143 M€ by end 2006.

The Court of Auditor[11] pointed out that the total TEN-T support for EGNOS until 2004 was above the maximum threshold of 20% allowed by the Regulation. However, following the decision the integration of EGNOS into Galileo, the sum of EU contributions granted for each programme by end 2006 will be below the maximum threshold of 20% of the total investment cost for GNSS as set forward in the TEN-T Regulation.

Table 2.3 Financing of EGNOS

Phases of EGNOS	**EC Contributions in M€**	
	In 2003 (COM (2003) 123 final)	In 2006 (updated estimates by GJU)
Estimated total Investment cost	310 (up to 2003)	616
EU contributions (1995-2003)	116.4	143 (1995-2006)

In sum, the table shows:

- that total investment cost for developing and deploying EGNOS system has been twice higher than estimated in 2003.
- that EC contributions to EGNOS committed over the period 1995-2006 will reach 143 million Euro which is lower that expected in 2003

[8] Following Revision of the MIP, EGNOS was integrated into Galileo and therefore included in the MIP.
[9] Operational Qualification Review
[10] According to interview with GJU officials.
[11] Special Report N°6/2005 on TEN-T.

- that savings are expected from the integration of EGNOS into Galileo when commercial operation will start but its level will be based on the results of the negotiations with the future concessionaire.

The cost of Galileo (GNSS 2)

The 2001 MIP (indicatively) earmarked EC contribution totalling 550 M€ to Galileo for the period 2001-2006 which corresponds to approx. 20% of the MIP budget for the same period. The total cost of the validation and development phase for the period 2001-2005 was estimated to 1.100 M€. Thus the EU contribution for this phase was fixed to maximum 50%; the remaining 550 million being committed through ESA budget.

The 550 M€ was committed through annual instalments (5 standard MIP Decisions) as follows:

- 2001-EU-1501 A S (30 M€) paid directly to ESA who was the applicant as the GJU was not existing at that time
- 2001-EU-1501 B (70 M€) ; applied by, paid to and managed by the GJU
- 2002-EU-1501A-S (170 M€) ; idem
- 2003-EU-1501-S (80 M€) ; idem
- 2004-EU-1501A-S (100 M€); idem

Two additional Decisions were taken in 2005 and 2006 for a total of 100M€ (76+24) to support the estimated cost of the validation and development phase, bringing the total EU contribution to the Development and Validation phase to 550 M€.

Cost increases

Until 2004, the various Communication on Galileo were stating that according to best estimates the total cost of the Galileo project for the period 2001-2007 would be 3,200 M€. Taking into account the 20% maximum TEN-T support for GNSS, the EC contribution could reach 640M€. The 2004 revision of the MIP presented by the Commission proposed to allocate 680 Million to Galileo (20% of 3,400M€)[12]. Based on these provisions, a new request will be presented in 2006 for a grant of 130 M€ for the first year of the deployment phase.

The deployment phase will be mainly financed by the Concessionaire. The Commission will also contribute to the programme via a new financial instrument for the Galileo Programme which means Galileo will have its own budget line.[13].

Based on revised costs estimates made by ESA and confirmed by GJU, the Commission acknowledged in early 2005 that the development and validation phase would cost up to 400 M€ more than foreseen (see 4.3.1 for detailed analysis of this issue), cf. table below.

[12] Annex I to Commission Decision C(2001) 2645 of 19 September 2001 as amended by Commission Decision C(2005) 213 final of 3 February 2005.

[13] The discussions on financial perspectives for 2007-2013 are still in progress at the date of this report but according to interviews 900 Million Euro should be reserved for Galileo.

Table 2.4 Overview of cost increases

Phases	Estimates up till 2004 (M€)	Current estimates (M€)
Development and validation phase (2001-2005)	1,100	1,500
Deployment phase (2006-2007)	2,100	2,100
Total	3,200	3,600
MIP provisions for Galileo	550	680
Maximum TEN-T support (20%)	640	720

The table below summarizes the EU contributions to Galileo since 2001 and the expected Galileo budget line from 2007.

Table 2.5 EU contribution to Galilo (M€)

Phases	Total estimated cost in M€	2001	2002	2003	2004	2005	2006	2007-2013	Total	Sources of co-funding
Development	1.100	30	240 (70+170)	80	100	76	24		550	TEN-T
	(cost overruns 400)						130	50 from TEN-T 2007	200 (50% of total cost)	TEN-T
Deployment	2.100							pm	pm	GSA
Exploitation	220/year							pm		not decided yet

Source: DGTREN

The table shows:

- that the EC contribution committed by end 2006 to the Galileo from TEN-T MIP budget will amount to 680 Million Euro (550+130) for the period 2000-2006 covering partly the cost overruns.
- that as the current TEN-T Regulation allows to found up to a maximum of 20% of the total investment cost, an additional TEN-T contribution of 50 Million Euro could be mobilized from the Commission either from MIP reserve, non-MIP budget in 2007.
- that annual cost of operation once the system is deployed is still not estimated with sufficient accuracy nor the level of EU contribution to be committed for this phase.

Total costs of GNSS 1 and 2

Following the integration of EGNOS and Galileo, the total cost investment for the development and deployment of the European GNSS programme is estimated to reach 4,216 M€ (616+3,600) for which the EU TEN-T contribution over the 2001-2006 period would amount to 803 M€ (143+680) which corresponds to a level of co-financing of 19 %.

3 Effectiveness

Purpose of chapter

The challenge for all projects being composed of numerous different activities, like the Galileo project, is to secure that the individual activities converge towards a common objective. This is what effectiveness is about: the extent to which the objectives have been achieved. The chapter is structured so that it progressively answers the specific evaluation questions on effectiveness, which are listed in the text box below.

Text box 2 Evaluation questions on effectiveness

- What are the objectives of the entire Galileo project, and what are in particular the objectives of the development and validation phase?
- To what extent have the objectives of the development and validation phase been met?
- How effective has the process of concluding international agreements been, and what factors explain that is has been possible to conclude several important agreements in a relative short period of time?
- Which factors explain the apparent successful implementation of the development and validation phase in context of the broader Galileo programme in terms of commitment, delivery and progress?

3.1 The objectives of Galileo

3.1.1 Objectives of the entire project

A global system for civilian use

A review of relevant Communications and Council conclusions since 2000 shows that the overall objective has been constant, namely to establish a global navigation satellite system based on the following principles: targeted civilian use, offering a broad range of services, offering performance improvement compared to the GPS-system, and should involve public-private partnerships.

The motivation of Galileo constantly focuses around three dimensions: the political, the economic and the technological dimension.[14]

The political dimension

The formal documents seldom specify what is meant by the political dimension. Review of documents and talks with experts show that the political dimension can be disaggregated into the following specific elements:

- An *external symbolic element*: As well as being a technological achievement, Galileo will be a political statement of European independence from the United States in GNSS. It proves to the outside world the determination of the EU to be at the forefront of technological development.
- An *internal symbolic element*: Proving to Member States and European institutions that they have the ability to launch coordinated actions towards achieve long-term objectives.
- *Security dimension*: Providing independence in satellite navigation.
- *Providing closer links with third countries*: Via the completion/preparation of agreements with several third countries, the EU establishes strategic links with a group of important countries.

The economic dimension

The economic dimension can likewise be broken up into a number of more specific elements which are the following:

- *Commercial potentials.* Market and income potentials for European industry.
- *Employment:* The number of jobs created as a result of the European system of satellite radio navigation should be in the region of 100 000.
- *Social and welfare benefits*: Satellite radio navigation will become part and parcel of the daily life of European citizens. A cost-benefit analysis showed benefits of Euro 17.8 billion in NPV terms and costs at Euro 3.9 billion, implying a benefit: cost ratio of 4.6. This is regarded as a strongly positive ratio.[15]

The technological dimension

The technological dimension can finally be summarised in the following points:

- *Development:* To develop the technically most sophisticated navigation system available.
- *Interoperability.* To make Galileo interoperable with existing systems.

[14] The latest progress reporting in fact begins by saying directly that 'The Galileo research programme (Galileo programme) has a threefold dimension: it is technological, political and economic…' (COM, 2004, 112 final).

[15] Cf. the study *Inception Study to Support the Development of a Business Plan for the GALILEO Programme*, PriceWaterhouseCoopers, at requst of DG TREN (2001).

3.1.2 Objectives of the Development and Validation phase

Four key matters

The objective of the Development and Validation phase is, overall, to verify and test the assumptions made during the earlier definition phase, particularly with regard to the various components of the architecture of the Galileo system.

The structure for describing the specific objectives are to the degree possible kept consistent with the most recent EU Commission progress reporting (COM (2004)636 final) that refers to four fundamental matters that needed to be settled in the Development and Validation phase. These matters are listed in the below table along with related objectives.

Table 3.1 Objectives of the Development and Validation phase

Specific objectives (cf. EU Commission progress reporting).	Related sub-objectives
International. Agreement with USA on interoperability of GPS and Galileo	• To sign international agreements with countries having an interest in Galileo and being commercially interesting markets
System development. Validation 'in orbit' and the definition of services offered	• To define in detail the key segments (space, ground, user) • To develop the satellites and the ground-based components • To launch first satellite/validation in orbit • To integrate EGNOS and Galileo
Financing and operation. Confirmation that there will be significant contribution from the private sector, including PPP process	• To prepare tender materials • To evaluate proposals • To document revenue potentials and commercial viability
Management. Structures for the management of the system	• To set-up the Galileo Joint Undertaking • To prepare future management of the system

3.2 Extent of goal fulfilment

This section describes the extent of goal fulfilment of the development and validation phase.

Table 3.2 Extent of goal fulfilment

Objectives of the Development and Validation phase	Objectively verifiable indicator	Level of goal fulfilment cf. progress reporting
Agreement with USA on interoperability of GPS and Galileo	Agreement signed 26/6-04 Press release (IP/04/805)	High
The definition of services offered	COM (2004)636 Final Mission High Level Definition Version 3.0 (ESA, September 2002)	High
Confirmation that there will be significant contribution from the private sector, including PPP process	Transport Council Decision, 10 December 2004 Tender materials Proposal submitted by Merged Consortium	Medium Final confirmation on private funding not yet achieved, expected to be achieved ultimo 2006
Structures for the management of the system	Council Regulation (EC) No 1321/2004 setting up the Supervisory Authority	High

On the US agreement

The agreement was concluded 26 June 2004 on the promotion, provision and use of the two satellite-based navigation systems. The agreement allows each system to work alongside the other without interfering with its counterpart's signals. The agreement came about after more than four years of intensive talks.

On definition of services offered

The five services were defined at an early stage (around 2002) and have remained; hence there is a high degree of stability in service definition.

On PPP process, etc.

The Galileo project is innovative therein that it was the first time a major European investment project was financed via a PPP arrangement. The PPP element was stressed at an early point in the decision-making process and the experts interviewed confirm that it was a precondition for political commitment from Member States. The PPP process is analysed in some detail in section 4.2.1. Here it suffices to say that the PPP process has advanced to a stage where GJU is preparing to enter a final agreement with the Merged Consortium (MC)[16] during 2006 but a final confirmation of private funding and risk sharing

[16] In May 2005, the two bidders that could become the future concessionaire (Eurely consortium, iNavSat consortium) merged to become what is known as the Merged Consortium (MC). See further in Chapter 4.

has not been achieved within the time frame set by the relevant Transport Council Decision.[17]

On Structures for the management of the system

The European GNSS Supervisory Authority was established by a Council conclusion of 12 July 2004. The GNSS Supervisory Authority has started to work and 15 persons are already employed.

3.3 Effectiveness of concluding international agreements

Motives

International cooperation has been an essential component in developing the Galileo programme, both in order to ensure maximum benefits from Galileo as a global satellite navigation project and from EGNOS with its regional dimension. This section describes the process of concluding international agreements.

The motives behind the international cooperation have been to ensure interoperability and compatibility with the existing systems, to open up for cooperation and partnerships with third countries and to define Galileo standards for use in international markets including legal aspects, promoting trade and European industrial know how, as well as installation of ground segments compliant with Galileo globally.

Status

At present (May 2006) a number of cooperation agreements have been made between the EU and third countries from various regions of the world. Table 3.3 summarises the status of agreements made to date according to nature of the agreements and context as well as main future expected agreements.

Table 3.3 Status of EU/MS agreements with Third Countries

Country	Agreement between EC and MS	Agreements with ESA/GJU
China	Agreement and ratification underway	GJU and ESA agreement
United States	Agreement and ratification underway	ESA programme cooperation
Israel	Agreement and ratification underway	GJU agreement and ESA talks
Ukraine	Agreement signed	ESA talks
India	Agreement Initialled	ESA agreement
Russia	Negotiations on hold	ESA agreement
Morocco	Agreement Initialled	-
Norway	Negotiation underway	Member
South Korea	Agreement Initialled	-
Argentina	Negotiation underway	-
Switzerland	Planned	Member
Saudi Arabia	Planned	-
Canada	Planned	Cooperation with ESA
Others[18]	Initial stages/expected	-

[17] The Transport Council in December 2004 asked the GJU to complete the concession contract in the course of 2005.

[18] E.g. Australia, New Zealand, Japan, Malaysia, Brazil.

Agreement criteria

The criteria for making agreements between the EU and third countries are the following (criteria listed after importance):

- The most important future markets from a commercial perspective (e.g. China, India)
- ESA members not being EU Member States (e.g. Norway and Switzerland)
- Neighbouring countries because of importance for energy and transport sector as well as inclusion to EGNOS (e.g. Russia, Ukraine, North Africa)
- Achieve presence in Latin America (e.g. Brazil, Argentina)
- Achieve presence in Asia (South Korea being producer of semi-conductors)
- Japan; developing own regional system but the door is open for further cooperation.
- Africa; Galileo/EGNOS would be an important tool particular for aviation, rail and maritime navigation in Africa.

The content of agreements

The agreements concluded with third countries mainly foresee their participation in technical and industrial activities through participation to the Galileo Joint Undertaking. The modalities of this participation are decided on a case by case basis. However, typical elements in agreements are:

- Definitions
- Principles of cooperation (such as mutual benefit, partnership, exchange of information)
- List of the scope of cooperation (such as scientific research, training, market development, trade)
- Principles and forms for industrial cooperation
- Activities on trade and market development (such as raise awareness of Galileo)
- Principles for regional and local level ground system
- Framework for funding of the country's contribution towards the Galileo programme.

Sensitive activities, such as those affecting the security of the system, remain outside the cooperation framework.

EU Involvement

The cooperation agreements are signed between the third country and the European Commission and the EU Member States as certain aspects of the agreements are outside Commission competences (security etc.).

In negotiating the various agreements, DG TREN takes the lead with input from various services depending on issue (legal, trade, commercial, research). ESA provides input mainly on the technical side and GJU took lead on the partnership agreements (See below) with China and Israel.

3.3.1 Four categories of cooperation

In the following international cooperation is described in four simplified categories reflecting the nature, content and involvement by the respective third countries.

This section is based on interviews with DG TREN and GJU, DG TREN and GJU press releases on cooperation agreements (from website), the EU US 2004 cooperation agreement, communications, and the presentation: "International cooperation in Galileo[19]".

Interoperability and compatibility with other systems

The first issues concern interoperability and compatibility between Galileo and GPS in the US and Glonass in Russia. The talks with the US and Russia began during the nineties, focussing on the issues of interoperability, compatibility, radio-frequencies, security and industrial collaboration. At the time EU was defining its satellite navigation strategy including EGNOS.

The US responded to these ideas with discussion of cooperation within the framework of GPS, offering certain levels of independence and ownership on the EU side. The EU responded by calling for negotiations and outlining its seriousness in having a satellite navigation system, putting forward concrete issues such as GPS-Galileo interoperability, infrastructure etc. based on a number of different system solutions.

In the following years, up to 2003, negotiations were troublesome and in late 2001, the US presented its position on the advantages of discarding the Galileo project. It was first after the 2003 agreement with China that negotiations with the US seriously began to progress.

Following the improved relations, the EU and US reached the 2004 agreement "Promotion, Provision and use of Galileo and GPS satellite based navigation systems and related applications". The agreement ensured full compatibility between the two systems and joint civil standards. Today relations are characterised as being cooperative in the field of both technical and political issues.

Glonass and Galileo are based on two different logics; however it should be possible to agree on mutual functioning standards. It is also being discussed, to have EGNOS ground stations in Russia for better European coverage and to run combined stations for the European and Russian systems. Despite EU interest in achieving an agreement, negotiations have fluctuated with Russia and came to a halt in 2001/2002. Negotiations resumed in 2003, but were followed by a slowing down in pace during 2005. However recent meetings in 2006 are expected to result in a draft agreement, likely to reach a conclusion in the near future.

[19] Presentation by DG TREN, 2006

EU cooperation agreements and co-funding partnership (bilateral approach)

In addition to the EU cooperation agreements (See below), China and Israel have signed further partnership agreements involving funding and cooperation directly with GJU. GJU was responsible for these agreements, involving a direct entry fee as well as contributions in kind. China was the first country to sign an EU cooperation agreement on Galileo in 2003, followed by the GJU agreement on closer partnership and co-funding of Galileo. The strong commitment made by China reflects its interest in being part of a global satellite system and the potential market and industry growth related to such system. Also, it seems that the strong interest from China has accelerated EU leader's commitment and the US to Galileo.

Israel signed its initial cooperation agreement in 2004 followed by the GJU partner ship agreement, involving delivery of services/hardware in kind particularly contributing with its small but specialised high tech space industry. Israel will also be part of the coverage of EGNOS.

EU cooperation agreements (bilateral approach)

One of the main reasons for bilateral EU cooperation agreements is to ensure the Galileo standard, freedom of use of Galileo, ensuring market access and provision of services and to prevent limitations to the use of Galileo. Under the WTO/GATT agreements many services are mutually recognised, however, satellite navigation and services can be classified under Telecoms for which there are more restrictive or no agreements. Not all countries have committed themselves to the WTO/GATT agreements. Therefore the EU had a strong incentive for obtaining bilateral EU agreements in order to achieve the full market potential of Galileo.

In some countries, the use of satellite navigation systems is being discriminated against in various ways, in some cases it is prohibited (civil and commercial use) in others there are licensing requirements which include fees. Therefore, being a global navigation system, a primary motivation is to ensure access to Galileo.

Several countries (China, India, Australia, Canada and Brazil) have planned or decided to build regional augmentation systems that are compatible with the Galileo system and GPS. For other countries close to or in longitude with the EU, these could take form as an extension of EGNOS by adding ground stations. There could be an interest in providing expertise and know how based on the European experience with EGNOS.

Ukraine and Morocco are examples of neighbouring countries who have signed agreements to use Galileo and to be a part of EGNOS coverage. Norway and Switzerland are particular cases, both are members of ESA but not part of the European Union. To date, both countries have had strong involvement in the project through ESA. To continue this involvement during the operational phases, it will be important for both countries to sign agreements committing themselves to Galileo/EGNOS, which will be operated by a concessionaire under the control of GSA.

The EU have promoted Galileo and emphasized the importance of the global coverage of the system. However, third countries often contact the EU on their

own initiative in order to obtain cooperation agreements. Media coverage following the development of Galileo is seen as an important driver for this interest. Also, third countries are aware that Galileo is being developed on the principle of Global use and cooperation, allowing for strong involvement from all countries. Finally, the predicted future market growth and job creation related to satellite navigation and high tech research and industry is a major motivation for third countries.

Regional development dimension

The regional dimension of Galileo aims at extending coverage and use of Galileo and EGNOS, particularly to the MEDA region, Latin America and Sub-Saharan Africa. The regional agreements focus more on use of Galileo than involvement in (developing) the system however, the agreements have a built-in development aspect, often involving Commission external development services[20].

As an example, navigation systems are often of a poor standard in Africa, therefore, having access to improved systems, would be beneficial in sectors such as aviation, rail and maritime. The African civil aviation organisation (ICAO/AFI) has agreed to extend EGNOS coverage to the African continent with joint use of GPS and Galileo as next step of their GNSS plan. The commercial value for EU industry is predicted to be limited in Africa. However, it is foreseen that regional industry could invent and develop more simplified applications, specifically targeted at the needs in Africa and at affordable prices for the African market.

3.3.2 Explaining progress

Factors explaining progress in concluding international agreements

Overall, the process of concluding agreements with third countries is an interactive process based on third country demand, EU political demand to have an open global system and the need to secure market access.

A main EU priority was that Galileo would be operational and compatible with exiting systems. Despite highs and lows in the discussions and negotiations with the two countries already possessing satellite navigation systems, it resulted in the 2004 EU US agreement[21] on Galileo/GPS. This was one of the important EU milestones.

China signed the first third country agreement which was a decisive moment in the development of Galileo, showing its strong and early commitment. China was followed by several other countries (India, Ukraine, Morocco etc) and more countries are in the pipeline. As more third countries have committed themselves to the Galileo system both technical and political risks have declined, again increasing the attractiveness and increasing the market potential of users and applications.

[20] EuropeAid, DG DEV and RELEX

[21] "Promotion, Provision and use of Galileo and GPS satellite based navigation systems and related applications"

For the EU it was particularly important to secure third country agreements, as Galileo is a newly introduced system. Market access and definition of standards are crucial. The interest of third countries has also been sparked by the potential of developing high tech navigation research and industry including the potential creation of jobs.

To facilitate international agreements, the EU established a framework for negotiations comprising criteria and priorities for negotiation and an overall content of agreements under which modalities can be agree upon depending on level of participation.

3.4 Explaining the progress of Galileo

Hypotheses on progress

As stated, according to the progress reporting from the Commission (COM (2004) 112 final, COM (2004) 636 final), the progression of the project has been satisfactory. Interviews with DG TREN officials likewise give the impression that the progress of the projects has been extraordinary. In the same tone, DG TREN in July 2004 found that progress was 'excellent'.[22] It is therefore relevant to identify factors which explain the successful implementation of the development and validation phase in terms of commitment, delivery and progress[23]. In doing so, six hypotheses are advanced:

1 EGNOS
2 Politics
3 Social, economic and technological potentials
4 Implementation strategy
5 Institutional framework
6 Security and defence

Hypothesis 1: EGNOS stimulated interest in Galileo

The earlier EGNOS project stimulated interest in Galileo project. The idea of European involvement in GNSS was stimulated by the development of the EGNOS system in the mid 1990's and related research and development activities.[24] EGNOS was thus the technological driver behind Galileo which came to represent a logical continuation of Europe's involvement with satellite navigation.

[22] Cf. Granting of Community Financial Aid for Trans-European Transport Projects in the Framework of the Indicative Multi-annual Programme. Study appraisal for continuing actions, EU/2004/1501; signed 14 July 2004.

[23] An answer to this question is not only of relevance for an understanding of this particular programme but may also generate more general knowledge on enabling factors for successful cooperation between EU institutions and other institutions/stakeholders; hence the learning aspect is particularly interesting.

[24] EGNOS was adopted by the Council of the EU in 1994 in its resolution on the European contribution to the development of a global navigation satellite system. In 1996, satellite radio navigation was included in the Community guidelines of the trans-European transport network.

The evaluation shows that the spill-over from EGNOS to Galileo was an important background factor. The most important influence of this factor consists in its eye-opening function: EGNOS indicated the technological potential of Galileo and also showed political decision-makers that Europe could come to play a significant role in GNSS.

Hypothesis 2: Politics

The Galileo project is given high priority because of its political dimension. The political dimension of Galileo consists of four elements: An external symbolic element, an internal symbolic element, independence element, and a wish to establish closer cooperation with third countries (cf. section 3.1.1). To this should be added the widespread annoyance over what was perceived to be US reluctance to involve Europe in the upgrading of the GPS system. According to this hypothesis, it was the possibility to achieve the political objective that drove the project forward.

We have had confirmation that the political dimension has been essential and a key factor in securing momentum. This is also evident from reviewing relevant Transport Council decisions. It has also been noted by analysts that the 'European' nature of the project symbolises Europe as an actor which amounts to more than the sum of its Member States government's decisions[25], thereby facilitating the active commitment of European institutions such as the EU Parliament and the EU Commission. However, our compilation of viewpoints indicates that it was not the political idea of Galileo *per se* that led to launch of R &D activities to develop the necessary technology but rather the other way round: technological perspectives were documented (e.g. via EGNOS) and only subsequently were the political opportunities hereof perceived, and ultimately concluded to be important.

Hypothesis 3: Social, economic and technological potentials

Galileo project is given high priority because of its social, economic and technological potentials. It is the argument that Galileo creates a range of applications giving welfare benefits, in addition to fostering employment opportunities. Furthermore, the Galileo project provides flesh-and-blood to the Lisbon strategy intention of creating the knowledge-based economy, and these potentials have functioned as persuasive arguments.

[25] See for instance the article 'Galileo: A cornerstone of the European Space Effort', Xavier Pasco (2001): 'The GNSS initiative has been managed from the start at the European level, involving the European Space Agency and the European Union. As such, Galileo is perceived as an important step by the European institutions themselves in building their relationships with the European Member States. In many respects, Galileo can be considered as a "premiere" as far as European institutional life is concerned. Even if the multi-dimensional nature and the complexity of political Europe is often underestimated in the United States, it has appeared as a main driving and structuring force behind the program'. See also recent article (in European Voice, Vol. 12, No 14) by MEP Etelka Barsi-Pataky, European Parliament rapporteur for the report on the implementation of the deployment and commercial operating phases of Galileo. She write: 'Galileo is the first 'made in Europe' project that involves the EU as major partner in the Space application field'.

We have received confirmation, that there is a widespread understanding among national and European decision-makers that the broader potentials of Galileo fuelled the progress of the project. But, as the full technological and economic potential of Galileo was unknown when the idea of Galileo was conceived, this hypothesis cannot explain the initiation of Galileo but only why the interest was sustained. Hence, this factor only became important as a driving force *when* it was justified that the potentials were immense (e.g. via the 2001 and 2003 Price Waterhouse Coopers studies).

Hypothesis 4: The implementation strategy

Galileo project progressed well because of a particular implementation strategy. This hypothesis focuses on the content of the implementation strategy arguing that the strategy was very well adapted to the challenge. The implementation strategy can be summaries as follows:

- *Determination*: High level of determination although the project in its entirety and the outcomes could not be foreseen from start. An above-average willingness to accept risks.
- *An incremental planning approach*: Solve problems when they arise rather than claiming full insight into all likely challenges.
- *Step-by-step*: Slicing the project into phases with specific output requirements, allowing a 'no-go' decision at the end of each phase.
- *Tailor-made organisational design*: The organisational design deviated from phase to phase reflecting the specific challenges. In particular, the GJU was established for the Development and Validation phase as a novelty in organisational design.

Our compilation of viewpoints indicates that this factor has been essential and is a key in understanding progress. Please note that a fuller analysis of the GJU model is given in section 4.1

Hypothesis 5: Institutional capacity

Galileo project progressed well because of an effective macro-institutional framework. While the previous hypothesis emphasised the 'narrower' management aspects of the process, this hypothesis starts by arguing that, for a project like this to be successful a number of capacities should exist: the capacity to provide finance, the capacity to regulate, the capacity to pass legislation, the capacity to high-level technological innovation, and the capacity to provide legitimacy. These capacities were exactly brought into this process by drawing on a number of institutions that all 'played their role'. ESA provided technical insight, the Council and parliament political legitimacy and regulation, etc.

It is our understanding that this factor should be perceived as a framework condition; a necessary but not sufficient factor. It was necessary therein that the political and economic potentials could only be achieved because of the framework.

Hypothesis 6: Security and defence

Galileo project is given high priority because of its 'hidden' security and defence dimension. If the EU finds it necessary to undertake a security mission that the US does not consider to be in its interest, it will be incapable unless it has the satellite navigation technology that is now indispensable (Pasco, 2006). Following this line of reasoning, Galileo will underpin the common European defence policy that the Member States have decided to establish. Although designed primarily for civilian applications, Galileo will *also* add to the military capability, as said in an information note from DG TREN:

> 'And last but not least, Galileo will underpin the common European defence policy that the Member States have decided to establish. There is no question here of coming into conflict with the United States which is and will remain our ally, but simply a question of putting an end to a situation of dependence. If the EU finds it necessary to undertake a security mission that the US does not consider to be in its interest, it will be impotent unless it has the satellite navigation technology that is now indispensable. Although designed primarily for civilian applications, Galileo will also give the EU a military capability'[26]

According to the experts consulted, however, the security and defence dimension was not the driver behind establishing Galileo, cf. the following observation:

> 'Member States, and more particularly the Ministries of defence, have adopted quite a low profile, appearing more as spectators rather than as primary actors. They were hardly in a position to directly support Galileo, judged as it was a civilian program from A to Z, i.e. both at its inception and in its main ultimate goals'. [27]

There are thus no indications that actors within the broader security-defence-military field were particular interesting in the project at an early point, nor to provide financing. Furthermore, the potential use of Galileo was not known in the initial phases at all.

[26] *Galileo, The European Project on Radio Navigation by Satellite,* 26 March 2002, European Commission, Directorate general Energy and Transport.

[27] Xavier Pasco (2001), Galileo: A cornerstone of the European Space Effort

Summary

In this section, six hypotheses were forwarded in order to reflect on the reason why the Galileo progress has been significant.

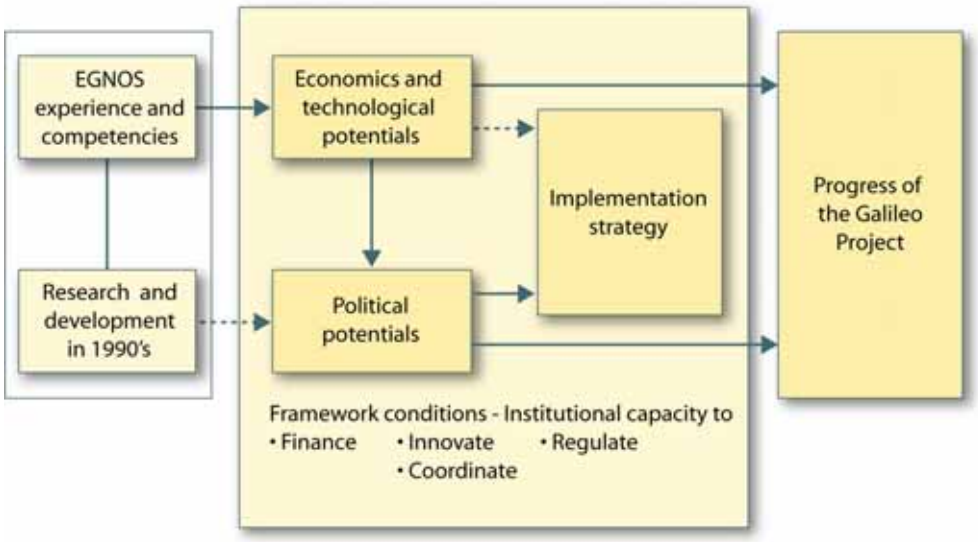
Table 3.4 Overview of the hypotheses and indication of their explanatory power

Hypothesis	Indication of explanatory power
1 The earlier EGNOS project stimulated interest in Galileo project	Plausible explanation. In particular useful for understanding why the Galileo project was initiated at all.
2 Galileo project is given high priority because of its political dimension	Plausible explanation - a key factor.
3 Galileo project is given high priority because of its social, economic and technological potentials	Plausible explanation - a key factor
4 Galileo project progressed well because of a particular implementation strategy	Plausible explanation - an enabling factor
5 Galileo project progressed well because of an effective macro-institutional framework	Plausible explanation - an enabling factor
6 Galileo project is given high priority because of its 'hidden' security and defence dimension	We have seen little evidence in support of this hypothesis

Observations

The discussion in this chapter has pointed to a combination of factors as decisive in moving the complex Galileo project from idea to plan to reality, cf. the figure below.

Figure 3.1 Explaining the progress of Galileo project



In particular, the political and economic potentials have been important factors but only when the technological potentials were demonstrated via EGNOS. As these potentials became more documented and accepted, it was of crucial

importance to develop an effective implementation strategy. The strategy was prepared and applied and became thereafter an important factor in itself towards progress. Finally, the above-mentioned factors were effective because of the institutional framework.

Furthermore, a particular chronology should be noted. Some factors were decisive at different points in the long decision-making process: *first* technological evidence /perspectives generated via R&D and EGNOS. It initiated the wider interest among broader segments of actors, and gave the push to document the economic perspectives. When the socio-economic justification was in place, political perspectives were *then* at the forefront to push the project forward through the difficult phases requiring decisions on financing.

3.5 Conclusion

- The overall objective of the Galileo project is to establish a global navigation satellite system based on the following principles: primarily for civilian use, offering a broad range of services, being a significant quality-improvement compared to the GPS-system, and should involve public-private partnerships. The Galileo project is motivated by political, economic and technological potentials that in total create a richly faceted argumentation which many different actors can accept.

- In light of the technical and institutional complexity, the overall progress of the Galileo Project is good. A combination of factors has been decisive in moving the Galileo project from idea to plan to reality, in particular:

    - Galileo has progressed well because of the political and economic potential, and the effective implementation strategy. Moreover, an effective institutional framework was able to provide the necessary financing, regulation, innovation and coordination.

    - Certain factors were decisive at different points in the long decision-making process: Technological potentials were in the first place demonstrated via EGNOS and it sparked an interest among broader segments of actors. When the socio-economic justification later was in place, the political and commercial perspectives came to be at the forefront of the argumentation to bring the project forward through the difficult phases requiring decisions on financing.

- The level of goal fulfilment of the Development and Validation phase is, overall, high. Three out of four tasks (USA-agreement, service definition, and future regulatory structures) are successfully completed while the public-private partnership, being the fourth task, is not yet settled. Significant progress is being made in negotiating terms with the Merged Consortium but conclusions on risk allocation have not yet achieved.

- The process of concluding international agreements has been successful as several countries are committing themselves to be future users of Galileo.

4 Efficiency

Purpose of chapter

This chapter presents the evaluation results on efficiency: the extent to which desired effects are achieved at reasonable cost. A concise overall efficiency assessment cannot be given because of the uniqueness of the project making it difficult to establish a benchmark. It was tried to compare the Galileo development costs with the cost of the US GPS system but for a variety of reasons the comparison cannot be precise. Efficiency is therefore, in the context of this evaluation, defined as relating to the efficiency of the particular organisational model chosen (the GJU), the efficiency of the GJU in meeting its obligation and the efficiency in avoiding 'optimism bias' in the planning process.[28] The chapter answers the specific evaluation questions listed in the text box.

Text box 3 Evaluation questions on efficiency

- Has the GJU, as an organisational structure, been efficient in the management of the development phase?
- Has the GJU been efficient in meeting its specific objectives?
  - in overseeing the establishment of a public private partnership
  - in developing a first series of satellites to ensure reliability of the Galileo system
  - in managing projects launched under the EU's 6th Framework Programme
  - In managing the integration of EGNOS into Galileo
- What is the level of Level of cost overrun? (what mitigating measures have been installed)?

Furthermore, the development costs of Galileo are compared with the development costs of the GPS.

[28] Although the efficiency assessment thereby in some aspects comes to resemble an effectiveness assessment, it was consistently throughout the evaluation tried to measure if the project could have been implemented in a more cost-effective way.

4.1 Efficiency of the GJU as new organisational model

Tailor-made organisation

The first efficiency question concerns whether the organisational set-up with the Galileo JU was efficient; a question of particular relevance as the Galileo Joint Undertaking is an innovative, tailor-made organisational construction set up in pursuant of Article 171 of the Treaty. It is mandated by the Council Regulation (EC) No 876/2002 whereas Article 1 reads:

> 'For the implementation of the development phase of the Galileo programme, a Joint Undertaking within the meaning of Article 171 of the Treaty is hereby set up for at period of four years. The aim of the Joint Undertaking shall be to ensure the unity of the administrative and the financial control of the project for the research, development and demonstration phase of the Galileo programme, and to this end mobilise the funds assigned to that programme.'

Statutes

The statutes of the GJU specifies e.g.:

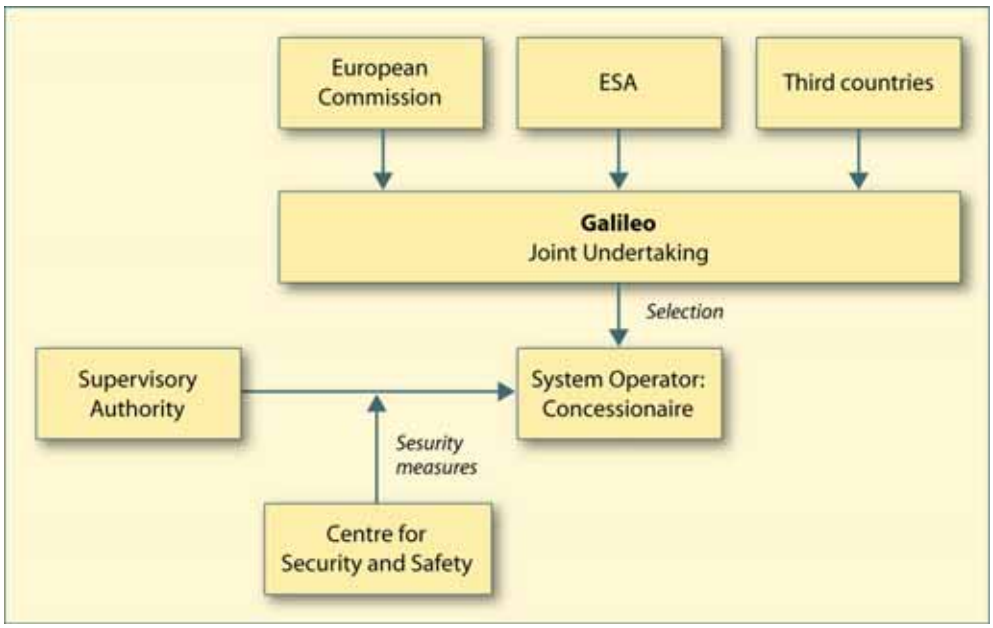
- The name and founding fathers (The European Community and the ESA)
- The main tasks (EGNOS integration, launch of satellites and associated activities, the PPP process, supervise the carrying out of all programmes)
- That the GJU have legal personality
- The bodies of the GJU and the functions and modus operandi of these: Administrative board, Executive Committee (Secretariat), and the Director.

No specific mention was made in the statutes that the Joint Undertaking would operate as an international organisation in terms of VAT. Consequently, Belgian law became applicable in matters concerning accounting, salaries and employment conditions causing additional direct expenditure of 6.8 M€ in taxes and operational costs[29]. The Belgium government counterbalanced this expenditure by an initial extraordinary contribution to GJU of 5 M€.

The relation of the GJU wiz its institutional environment is illustrated in the figure below.

[29] Source: Court of Auditor Report

Figure 4.1 The set-up of the Galileo Joint Undertaking



4.1.1 Characterising the GJU as an organisational model

In the regulation establishing the GJU, the new organisation is motivated in the following way:

> 'Taking into account the number of players who will need to be involved in this process, and the financial resources and technical expertise needed, it is vital to set up a legal entity capable of ensuring the coordinated management of the funds assigned to the Galileo programme during its development phase.'

The above motivation contains a number of concerns (underscored by the evaluator) which are clearly reflected in the chosen model. As an organisational model, thus, the GJU has three characteristics:

Temporary and targeted

The GJU is a temporary organisation which is to exist for a short period of time during which it shall solve specified tasks.

It is a management body

GJU shall ensure consistency of a project that affects very disparate stakeholders (industry, Member States, European institutions, etc.) and which are funded by different political-administrative systems (ESA: Inter-governmental, EU Community: Unitary actor). It must also allow public and private resources to be combined for a joint objective, and the GJU shall be flexible enough to be able to manage research projects itself or to interact efficiently and proactively with other initiatives. The GJU is given a legal personality and can conclude contracts required to develop the Galileo system. The GJU is subject to its own regulation/statutes and can be efficient and flexible in matters of operation, recruitment, procurement etc.

It shall reduce complexity

Created by EU and ESA, the GJU's purpose was to move forward the planning process in spite of the extreme institutional complexity in its environment. The

meta-function of the GJU can thus be described as *complexity-reduction.* The GJU was set up as a 'slim businesslike entity', as it was expressed by a DG TREN official, and it was deliberately designed so as to be sheltered from the institutional complexity surrounding it. But it is also stressed that it is an executive body that needs to maintain close links with the relevant authorities, first and foremost the founding fathers.

Public access to GJU information

In evaluating the GJU as a particular organisational model, it has been checked whether or not the GJU is subject to the provisions of Regulation 1049/2003 on Public access to EP, Council, and Commission documents. This regulation defines the principles, conditions, and limits of public or private interest governing the right of access to documents. The basic principle is to ensure the widest access to documents possible, in establishing rules for the easiest possible exercise of this right, and to promote good administrative practices on access to documents. All documents drawn up or received by institutions in all areas of activity of the European Union are covered by the provisions. Exceptions to this general rule are set forth in art. 4 and cover documents the disclosure of which may undermine the public interest regarding e.g. public security and defence and military matters.

It can be confirmed that the establishment of the GJU does not constitute derogation from the obligations held in the above-mentioned regulation. The GJU is subject to the principles and obligations of Regulation 1049/2001 on public access to documents, since this legal framework is of a general nature directed to all the Community Institutions. This means that, basically, any natural and/or legal person domiciled within the Community may request for access to documents drawn up or received by the GJU. Restrictions in granting access to documents drawn up or received by the GJU must be founded in the exceptions described in the Council's Security Regulation 2001/264/EC laying down a more detailed intra-institutional framework for the management and classification of documents.

Counterfactual description

Could the Galileo project have moved forward more efficiently without an organisation like the GJU? Based on our talks with experts involved and our general knowledge of complex planning processes, the answer is predominantly negative. Firstly, the GJU is placed between ESA and the Commission (DG TREN), which are two organisations with different missions and cultures: ESA being the downstream technical space expert institution and the Commission being a political and regulatory institution. By creating a new organisation, both institutions could add core competences to the project while not constantly being in dialogue on everyday management matters. The evaluation confirms that the set-up has, overall, functioned well. In fact, the fact-finding for the evaluation gave examples of situation where the GJU has come to play a role in facilitating dialogue between the Commission and ESA on issues other than those related strictly to GJU. This is also an indication that the GJU has fulfilled its role as a coordination mechanism.

However, it must be noted that a few persons, while supporting the GJU model as such, nevertheless have felt that the GJU model would have been more

appropriate if more partners were involved and if the duration of its existence was longer.

Secondly, the organisational model of GJU is rapidly being copied by the Commission in relation to the development of other main projects and it is being praised as an ideal-type organisation in relation to the institutional complexity confronting the launch of major initiatives at European level.

A recent Communication from the Commission to the Council on the proposal to set up a Joint Undertaking to develop the new generation of European air traffic management system, called SESAR[30], makes explicit reference to the Joint Undertaking concept and calls it an effective tool 'which has proved its worth in the Galileo project'. We have also learned that the concept is under consideration for use with other projects characterised by public-private involvement, technological innovation, institutional complexity, and the phasing of activities.

Text box 4 GJU - the first experience

The Galileo Joint Undertaking (GJU) was established as an organisation based on Article 171 of the EC Treaty, allowing for such time limited instrument. It was first time the EC used this Article to create an institution. Therefore it was also the first experience of the EC to create a statute under this Article. Whereas the Article 171 creates the basis of the statute it was not explicit stated that the GJU would be an "International Organisation" in terms of VAT, consequently Belgium law became applicable for matters concerning accounting, salaries and employment conditions.

Highly efficient

In summary, it is concluded that not only was the model efficient and suitable for the Galileo project, it was an innovation with far-reaching consequences as the model is being copied for use in other situations characterised by their institutional complexity and the need to ensure responsibility within a single, simple and flexible entity.

[30] COM (2005) XXXXX. Communication from the Commission to the Council on the project to develop the new generation European air traffic management system (SESAR) and the establishment of the SESAR Joint Undertaking.

4.2 Efficiency of GJU management

This section analyses how efficient the GJU has been in meeting its main obligations.

4.2.1 In managing the establishment of a private-public partnership

Process of establishing PPP

The first obligation is to oversee the establishment of a public private partnership between the public and the private sector in order to manage the Galileo Programme and to mobilise the required funds.

In 2001, the *Inception Study to Support the Development of a Business Plan for the Galileo Programme (PWC / TREN/B5/23-2001)* explored methods of structuring PPP in order to attract private sector investment at an early stage to minimize investment risk for the public sector. The study recommended that the PPP should be implemented by awarding a Concession to a private concessionaire.

In 2003, *Galileo Study Phase II (PWC / 17 January 2003)* analysed selected issues, including the PPP process, the Intellectual Property Rights and Revenue Generating capacity of the Galileo Concessionaire and EGNOS. In relation to the PPP process, a number of criteria hereof were advanced. They are used below as benchmarks of the process.

In **October 2003**, the competitive process to obtain the Galileo concession, started. Four consortia answered the call for interest launched by the GJU. Two consortia remained in the running for the competitive negotiation task held from April 2004 to January 2005. On **1st March 2005**, the GJU invited the two consortia for parallel negotiations on the concession contract. The two consortia are Eurely (core members: Aena, Alcatel, Finmeccanica, Hispasat) and iNavSat (core members: EADS Space, Inmarsat, Thales).

In **May 2005**, the two consortia expressed their intention to join forces. GJU accepted the request subject to five requirements (e.g. legally binding confirmation that the MC should not have any legal problem in sharing responsibility; that the MC was not in an anti-competitive position; the formal decision-making power by the MC being guaranteed). The MC submitted a Joint Bid on **21st October 2005.** Negotiations between GJU and MC led to a General Agreement on Principles dated 17th February 2006. It is foreseen that Contract Close will be achieved ultimo 2006.

In **December 2005,** upon request of the Transport Council, the Commission initiated an independent *Reasoned Analysis of the Concession Contract* including a Public Sector Comparator / Value for Money Analysis. The objectives of the Reasoned Analysis is to assess the benefits from the concession contract in comparison with a public funding and implementation of the project through a Public Sector Comparator (PSC) and to assess the size of the contribution from the public sector and evaluate the risks incurred by the public sector. Some of the conclusions were rather critical.

How efficient was GJU?

The discussion, documented in the following paragraphs, on efficiency is inspired by the criteria suggested by Price Waterhouse Coopers studies[31]. These suggestions are, principally, in line with DG TREN's own recommendations[32] describe the PPP project cycle and the requirement which should be met in each phases.

Table 4.1 Assessment of the PPP process against criteria

Criteria	Assessment
Initial study of various PPP models in order to prepare a basis for selecting an optimal model	Was carried out in the form of the Price Waterhouse Coopers studies
Public Sector Comparator (PSC) to be developed at an early stage in the process, preferably prior to announcement of the tender[33]	PSC was constructed late in the process, during contract negotiation after pressure from one Member State. This meant that was little possibility to influence the process of the contract structure
Identify each risk and whether it should be transferred to the Concessionaire, retained by the public sector or shared.	It is unclear to what extent overall risk analysis of the project were conducted in the early stages of the project No risk matrix in the Merged Bid. Risk allocation is still under negotiation.
A least two credible bidders for the role of Concessionaire	Two bidders merged, implying that there is now only one bidder, the Merged Consortium
The ability of each competing concessionaire to procure the Galileo System in a cost effective manner	The bidder is a consortium made up of the companies who developed the project (Galileo Industries). This means that the concessionaire has little incentive to seek alternative and more cost effective solutions.

The following should be noted:

- GJU did not develop a Public Sector Comparator (PSC) at the early stage of the tendering process, where there was a greater possibility of influencing the process of the contract structure. It could be argued that the need to develop a PSC is reduced in this context as the option of a public sector undertaking of Galileo a priori was excluded (cf. Article 2 of the GJU statutes referring to the task to 'mobilise the public and private funds…'). However, this misses the point that the PSC, in any case, would have provided a benchmark against which to measure the overall benefit of

[31] Inception Study for the Galileo Business Plan (2001) and Galileo Study Phase II Executive Summary (2003).

[32] PPP; introduction, handbook, Recommendations and conclusions (PROFIT series: private operations and financing of the TEN's (task 11.5), NEI, 2001

[33] The Public Sector Comparator is a tool to quantify the costs and revenue generating potential of undertaking the project under public sector control.

private sector bids for the PPP and consequently improve the public sector negotiating position. Developing a PSC will also create an additional incentive for bidders to offer competitive solutions.

- It is unclear to what extent the overall risk analysis of the project and risk allocation was established prior to the procurement of the concession. Risk allocation is still under negotiation.

- GJU did ensure competition i.e. four consortiums pre-qualified and two consortium submitted bids.

- When the two bids merged, giving raise to concern over the possible monopoly position of the MC, GJU took action to ensure that the MC would not be in an anti-competitive position.

Negotiated procedure

In sum, competition between concession bidders is crucial towards achieving value for money. In the context of Galileo it was clear that it would be difficult to ensure competition due to the limited number of providers of the necessary technology within Europe, and the difficulties of forecasting revenues. Accordingly, *negotiated procedure* was recommended for the procurement of the concession. This is a two-phased tender procedure, with the possibility for post-tender negotiations on contract specifications, and to gradually reduce number of competitors in time.

4.2.2 In preparing large-scale demonstration of the Galileo system

The second obligation of GJU is to prepare through ESA a first series of satellites to ensure the large-scale demonstration of the capabilities and reliability of the Galileo system.

Role of GJU

ESA will be responsible for the definition, development and in-orbit validation phase of the programme. Two test satellites and a set of four initial constellation satellites will be developed, together with the necessary ground infrastructure and test user receivers for system validation purposes. It is also an important goal to develop the receivers and local elements and to verify the frequency allocation conditions imposed by the International Telecommunication Union.

Initial satellite launched

The first Galileo test satellite GIOVE-A satellite was launched December 28, 2005. January 12, 2006 the first Galileo navigation signals were transmitted by GIOVE marking the first step towards full operability of Galileo.

Frequencies secured

This signal also secured the use of the frequencies allocated to Galileo. This was an important milestone as 2006 was the deadline for securing the rights to the frequencies.

Initial contract for first 4 Galileo satellite signed

Following these achievements ESA and Galileo Industries signed the contract for the development and in-orbit validation of the first four satellites on 19 January 2006.

This is the first step of the operational phase of Galileo and the four satellites will be the minimum requirement to guarantee precision, positioning and synchronisation over a selected area.

After the in-obit validation phase, the full deployment of Galileo will take place by manufacturing and launching the remaining 26 satellites, including completing the ground segments (ground stations and service centres). This will be undertaken by the concessionaire.

The process of GJU

The development and in orbit validation phase experienced delays mainly due to political decision making, negotiations with the US on joint agreement and new requirements leading to design changes particularly related to security concerns raised by the Galileo Security Board.

Despite these difficulties eventually leading to certain cost increases (See Chapter 4.3.1), the continuation of the process and future funding was agreed upon. Thus the overall aims of the development and in orbit validation phase has been achieved or are on track, despite political difficulties and requirements of design changes.

Whereas overall the GJU is credited for its part in this process particularly administration and financial control, therefore a high degree of efficiency, this task in itself is very likely to have been administered as efficiently by DG TREN (depending on availability of resources).

4.2.3 Managing projects under the 6th Framework Programme

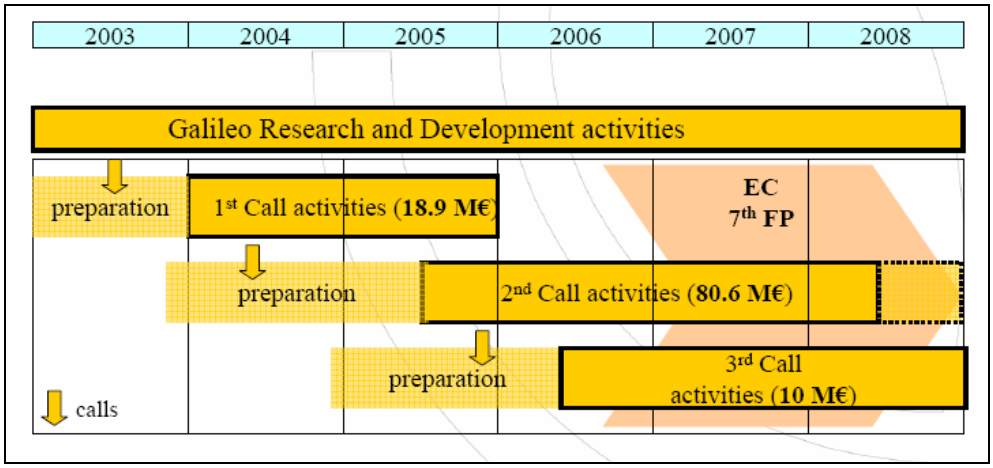
Introduction

The third obligation consists in managing projects launched under the EU's 6th Framework Programme for Research and Development. The GJU has been entrusted with the management of the EU contributions provided by the EU R&D budget (6th Framework Program) over the period 2002-2006. These 6FP grants are meant to co-finance the User segment of Galileo which is of paramount importance for the success of Galileo for two reasons: the real market for Galileo is in the User Segment and its development gives to Europe a chance to benefit from Galileo.

There was no obvious benchmark for assessing GJU's managements of the 6th FP as the Commission has been reluctant to externalise the management of its research programmes since 2000 and no other Join Undertaking exists to date.

Since 2003, the GJU has organised 3 calls for proposals for a total grant budget of 110 M€ at EU level (6th FP), cf. the figure below.

Figure 4.2 Galileo Research and Development activities



The aims of the three calls for proposal

The first call for proposals focussed of the Applications and Services development based on EGNOS integrity and on development of tools and first receiver prototype

The second call was oriented towards projects contributing to the development of GNSS services and applications in several major user communities: all major transport domains, scientific and professional domains, agriculture, standardisation, activities complementing GalileoSat, time and geodesy Service Provision, etc. It also supported research projects aiming at the development of commercially oriented receivers (mass market receiver, Professional receiver, Safety of Life receiver, etc.)

The third call - results will be known by mid-2006 - are targeted to five specific themes:

- Tracking and Tracing Technologies for EU Regulated Services: Support to introduction of GNSS in existing or planned EU regulation and initiatives
- Galileo Applications in the Emergency Management: Consolidate the potential of Galileo in support to emergency management and promote its use in the user community
- Galileo Time and Synchronisation Applications: Support the introduction of GNSS in the Time and Synchronisation User Communities, and develop this market
- Public Regulated Service User Segment: Promote the use of PRS in different User Communities, analyse the different aspects linked to the use of PRS
- Education, Research and Innovation in the field of GNSS: Analyse and draft recommendation on the improvement of the European situation in term of education, research and innovation in the field of GNSS.

These projects, with a combined estimated budget of 110 MEUR, often complemented by national or regional budgets, will deliver many of the key technologies required for the implementation and operation of Galileo, and repre-

sent another opportunity for the private sector to participate in the development of Galileo.

GJU's management activities

In order to fulfil this task, the GJU has organised the following management activities:

- The GJU is responsible of the whole project cycle: preparation of the calls, publication of the calls on its own web site and not on CORDIS, organisation of information days, assessment and selection of proposals involving external evaluators, contracting, monitoring and follow-up, disbursement of the FP grants
- The GJU has defined its own set of operating and procurement rules for the 6th FP activities and contracts.
- The funding levels of the 6 FP projects funded by the GJU are up to 50% with the following exceptions:
  - Costs for Management of the Consortium: up to 100%, with a maximum of 7% of the total costs
  - Non-commercial or non-profit organizations: up to 100%.

For all calls, the participation of SME's shall correspond to at least 10% of the total cost and the participation of research institutes shall correspond to at least 5% of the total cost.

The interviews showed that the management of the 6 FP by GJU was perceived as efficient and as on one domain where the GJU action was well received.

In theory the same activities could have been done internally in DGTREN if sufficient staff had been hired or allocated to focus exclusively these tasks. The fact that the 6FP activities have been managed and technically monitored by dedicated and specialised GNSS experts within the GJU certainly contributed to the efficient and timely achievement of this task.

Summary and assessment

Results and outcomes of its management can be summarised as follows:

- GJU has launched more than 60 projects (including SMEs) dedicated to the development of the User Segment for an overall budget of 170 M€ (110M€ financed by GJU)

- According to GJU, more than 200 companies (including a large number of SME's) are now involved in the Galileo R&D activities financed by the GJU and this represents 280 equivalent full-time persons are continuously working in these projects

- The first call is ongoing for all activities that are all close to completion. The second call is ongoing for all activities.

The above leads us to assess that the GJU conducted this particular task quite efficiently

4.2.4 In managing the integration of EGNOS into Galileo

Introduction

The fourth obligation concerns the managing of the integration of EGNOS into Galileo. The Council had often reiterated the need to plan the integration of EGNOS into the Galileo programmes. This was formalised in the Communication of the Commission from 2003[34] that was prepared in close collaboration with ESA, Eurocontrol, IATA and EOIG[35]. EGNOS should significantly contribute to the success of Galileo:

- Being a precursor to Galileo (the first stage of GNSS);
- Easing the implementation of Galileo
- Allowing the interoperability with GPS
- Exploring the market potentialities
- Allowing economies of scales during operation
- Favouring industrial development

Text box 5 The EGNOS system and stakeholders

EGNOS is a joint project of the European Space Agency (ESA), the European Commission (EC) and Eurocontrol, the European Organisation for the Safety of Air Navigation (Tripartite Group).

The European Space Agency has overall responsibility for the design and development of the EGNOS system. It has placed a contract with a consortium lead by Alcatel Space of France to develop the system (the ground segment). When EGNOS is up and running, an operator will be selected to take responsibility for daily operations.

The European Commission is responsible for international cooperation and coordination and for making sure that the views of all modes of transport feed into EGNOS design and implementation.

Eurocontrol is defining the needs of civil aviation and playing a major role in testing the system. In addition, several national civil aviation operators and other organisations are supporting EGNOS development, testing and implementation.

Consisting of three geostationary satellites and a network of ground stations, EGNOS will achieve its aim by transmitting a signal containing information on the reliability and accuracy of the positioning signals sent out by the Global Positioning System (GPS) and the Global Orbiting Navigation Satellite System (GLONASS). It will allow users in Europe and beyond to determine their position to within 5 m compared with about 20 m at present, inform users of the errors in position measurements and warn of disruption to a satellite signal within six seconds.

Once operational, Egnos will offer 3 basic services:
- an open service (OS) available freely
- a commercial service (CDDS) available also via internet (encrypted)
- a safety of life service (SoL) offering guaranty and integrity to transport community

[34] COM (2003) 123 final

[35] the EGNOS Operator and Infrastructure Group (EOIG) that is made up of Air Traffic Service Providers that invested in EGNOS - originally 100 million Euro.

In its conclusions of 5 June 2003, the Council has endorsed the integration of EGNOS into Galileo and agreed that on a number of conditions including that the EGNOS programme should be placed henceforth under the control of the GJU that should be entrusted with:

- the task of supervising the management of EGNOS after the programme "Operational Readiness Review" has been completed in April 2004,
- the conclusion of an agreement with an economic operator charged with operating EGNOS from April 2004 with due regard to the opinion of those parties who contributed to the funding of the development and deployment phases of the EGNOS system,
- making recommendations for suitable arrangements concerning ownership of EGNOS assets, intellectual property rights and commercial exploitation rights.

The discussion that follows will assess the efficiency of the GJU in achieving this integration by analysing what has been achieved by the GJU as regards to EGNOS management since the 2003 Council decision.

Daily management

EU contributions in EGNOS programme are in practice managed by the GJU since 2004 with two full time technical and one part time lawyer dedicated to EGNOS management. This small team is supported by internal GJU staff and external technical experts on an ad hoc basis. A contract has been signed between GJU and EC for this specific task specifying how GJU should coordinate ESA and EUROCONTROL activities related to EGNOS.

The 2003 Communication estimated that EU contributions for the integration of EGNOS into Galileo could reach up to 33 Million Euro a year from 2004 to till 2006. The GJU presented applications for TEN-T funding in 2004 and 2005 for 10 Million Euro respectively. The 2004 Decision was granted to GJU and distributed as follows:

- 8 M€ to ESA (qualification of system operations , certification, system evolutions)
- 1.1 M€ to EUROCONTROL for operation introduction in aviation domain
- 0.9 M€ for GJU own procurement needs.

The integrated management of both systems have also favoured the integration at service provision level, both systems using same level definitions and common terminologies.

International aspects

GJU has pursued the extension of EGNOS to other parts of the world and more particularly in the Mediterranean region, due to its geographic proximity and economical relations with Europe. In this context, the European Commission launched the Euro-MED GNSS 3-year programme of training and demonstration activities on satellite navigation services in the Mediterranean area along with the relevant infrastructure development. Its management was entrusted to GJU and includes the following activities using 4.5 million EURO coming

from MEDA budget: GNSS Regional plan, training, services demonstration and GNSS Signal In Space provision.

Future ownership

The EGNOS system and infrastructure is currently owned by ESA. The GJU was entrusted to coordinate the discussion to transfer the future ownership of EGNOS infrastructure to GSA. Negotiations are currently taking place with EIOG and ESA and should lead to a EGNOS Framework agreement that will specify the conditions of ownership transfer and what ESA and EIOG will get as compensations or returns from their investment in EGNOS to date.

Operator of EGNOS management

The GJU has also the mandate to select an economic operator for the management of EGNOS. It was decided later that the Galileo Concessionaire will be also offered the concession of EGNOS (integration at concession level). GJU is negotiating with the Merged Consortium under which conditions he will operate EGNOS. GJU is also assisting in the discussion between ESA and the Concessionaire on the transfer ESA contracts with Immarsat (the lease of the 2 satellites), with Alcated (the ground segment) and ESSP (a consortium that has a 18 month contract to perform the operational validation of the system and complete and submit a Safety Case to the appropriate national (air safety) authorities. Another point of negotiation is the expected potential savings in operational costs when the 2 systems are operated by the same concessionaire. The operating of Galileo and EGNOS are estimated at respectively 220 million EURO and 33 million EURO per year. The PWC study has estimated that cost savings resulting from the integration could amount to 9% of combined operational costs. This point is still under negotiation.

Delays

In term of availability of EGNOS services, the programme has been delayed compared with the initial planning. The ground segment has been developed in 2005, the certification of the system has been contracted in summer 2005. It is expected to have free availability of EGNOS Open Service, EGNOS Commercial service and SoL service by end 2007.

Summary and assessment

In summary, the efficiency of GJU in managing the integration of EGNOS can be summarized as follow:

- Due to the unique nature of the GJU there was no reliable benchmark against which assess its level of efficiency when dealing with EGNOS integration and the efficiency assessment therefore is given based on interviews and Consultant views.

- The GJU has been fulfilling the tasks entrusted to him for the integration of EGNOS into Galileo. Taking into account the human resources made available, the GJU has managed to mobilise EU contributions from different programmes (although less than initially expected) and allocate the funds taking into account the international dimension of GNSS. The GJU in involved in facilitating transfer of EGNOS ownership and is negotiating operational costs and EGNOS integration with the Concessionaire.

- The results of the negotiations are still unknown to date as well as the level of potential savings. The result of these negotiations will probably be an

indicator of the efficiency of the GJU in this particular task. The total cost estimated of EGNOS has increased from an estimate of 310 M€ up to 2003 to reach 616 M€ over the entire period 1995-2006. The availability of the EGNOS services are slightly delayed compared to initial planning but should be available when Galileo concessionaire will start operations.

- The overall impression is that the GJU has been active in fulfilling its mandate regarding EGNOS integration with relative efficiency.

4.3 Efficiency in avoiding cost overrun

Budget increase of 402 M€

When the Council decided, in March 2002, to launch the Development and Validation Phase the cost was estimated at a level of 1,100 M€. The same amount was included in the EC Communication on Galileo published 22 November 2000 (COM (2000)750 final). In 2005, the costs and financial needs were updated showing an overall cost increase of 402 M€. The overall cost is now estimated at 1,557.4 M€ equivalent to 1,502 M€ in 2001 economic conditions. This is equal to an increase of app. 37%. The budget increase can be interpreted in two different ways.

Version 1: Cost increases are due to design changes

The first version is the conventional interpretation of cost increases. It argues that the cost increase is not a cost overrun since it can be justified in design changes and delays imposed upon the project by political decision-makers *after* the budget was given. The Galileo Joint Undertaking in June 2005 explained the causes of the cost increase[36], cf. the table below. It appears that the cost increase of 37% is due in particular to delays, new requirements and higher costs.

[36] *GJU analysis of the IOV phase additional costs and financial needs as presented by ESA,* Galileo Joint Undertaking, 22nd June 2005, version 4.

Table 4.2 Evolution of costs, cf. GJU report, June 2005

Causes	Explanation	2001 estimate	2004 estimate
Delays	Delays have led to a fragmentation of activities	110	214.7
Risk Mitigation	Risk mitigation measures at a higher level than anticipated	100	161
Launchers	Market prices increase	90	112.5
New requirements		0	151
IOV (without security)	Industrial proposal more costly than anticipated	660	815
Contingencies		87	53.2
ESA contribution to GJU		0	50
Total costs[37]		1,047	1,557.4

Following this interpretation the level of cost overrun is very low.

Version 2: Design changes and delays could have been anticipated

The other interpretation is given by the emerging literature on *optimism bias;* a concept used to capture the fact that there seems to be a systematic tendency for planners to be over-optimistic when planning mega-projects. Optimism bias typically shows itself in the form of underestimation of outturn cost. Innovative projects such as Galileo are inherently risky due to the long planning horizon and complex interfaces.

According to this interpretation, the cost increases are caused by legitimate occurrences and circumstances such as design changes and delays imposed upon the project 'from outside'. However, it argues that such changes are not exceptional but on the contrary are the norm; the standard situation to be planned for. In other words; a planner must know, that he does not know. This information shall be used actively in the form of reference forecasting i.e. comparing a given project with outturn costs of a group of similar projects.[38] In doing so the planner moves away from treating design changes and delays as 'surprises' to seeing them as 'normality'.

[37] 1,100 M€ initial budget less the 53 M€ for the definition phase.

[38] Reference class forecasting consists in taking an 'outside-view' on the particular project being forecast. The outside view is established on the basis of information from a class of similar projects. The outside view does not try to forecast the specific events but instead places the project in a statistical distribution of outcomes from this class of reference projects. Reference class forecasting requires the following steps: i) identify relevant class of past projects (in the case of Galileo it could be IT-projects, and other innovative projects), ii) establish a probability distribution and iii) compare the specific project with the reference class distribution.

Following this more critical interpretation, the development and validation phase sees a cost overrun in the range of 37%. While this is a significant cost overrun, it is by no means unusual, cf. the text box below.

Text box 6 Putting the Galileo project into perspective: Levels of cost overruns

Empirical studies show that large infrastructure projects are likely to generate cost-overrun, even though private involvement may reduce the uncertainty.

Bent Flyvbjerg *Megaprojects and Risk* (2003) has made a review of 280 public sector projects and concludes that cost overruns of 50 -100 % are common and cost overruns above 100% are not uncommon.[39]

Galileo is a unique project, and it might be difficult to find projects which are fully comparable for reference budgeting, but it is interesting to note that development projects (for instance IT) often have cost overrun of up to 200%.

In addition to these two assumptions it should be mentioned that the continuous involvement and political priority of Member States have benefited Galileo in many ways but have had a delaying impact when waiting for Council decisions to be taken, leading to increase in cost as the rest of the project was on stand by in these situations.

Summary

The efficiency of planning in regard to cost increases can be summarised as follows:

- The Galileo Development and Validation phase saw a cost increase of 37% in 2005 compared to the original 2001 budget. Design changes, higher costs and delays account for the increase.
- According to conventional planning practices, the level of cost overrun is very low as the cost increase mostly can be explained with reference to events occurring outside of the project.
- According to the 'optimism bias' school of planning the cost increase of 402 M€ should be seen as a cost overrun. It can be documented, empirically, that projects such as Galileo typically suffer from cost overrun for exactly those reasons mentioned (delays, design change, cost increases) and this information could have be incorporated into the planning phase via references forecasting. It would have demonstrated that the Galileo project - despite all its particularities - is in fact a 'traditional' project when it comes to likelihood of cost increases. Compared to similar types of projects (being innovative, complex, and with a long planning process) a level of cost overrun of 37% is not unusually high.

[39] See e.g. *Megaprojects and Risk: An Anatomy of Ambition*, 2003, by Bent Flyvbjerg, Nils Bruzelius, and Werner Rothengatter, and *Procedures for Dealing with Optimum Bias in Transport Planning: Guidance Document*, 2004, by Bent Flyvbjerg and COWI, for UK Department for Transport.

4.4 Comparing with the GPS system

This section seeks to benchmark the development and deployment cost of the Galileo system against the closest existing equivalent, the US made GPS (Global Positioning System). The comparison can by no means be complete, and the observations are of a very preliminary nature. It is based on expert assessments and a review of available information.[40] The table below gives a first overview of the two systems.

Table 4.3 The GPS and Galileo

	GPS	**GALILEO**
Nationality	USA	European Union
Launched	1995	2011
Coverage	World wide	World wide
Status	Military (primarily)	Civilian (primarily)
No of satellites	24 + 3 back-up	27 + 3 back-up
Services	A *Standard Positioning Service* available to all GPS users A *Precise Positioning Service* is a highly accurate military positioning, velocity and timing service available to users authorized by the U.S.	An *open, basic service* A *commercial service* facilitating offering enhanced performance A *Safety of Life Service* of high quality and integrity (aviation) *A search and rescue service* that will improve rescue services. *A public regulated service* encrypted and resistant to jamming
User costs	Standard service provided for free	The basic service provided for free

While some aspects of the systems are relatively identical, the systems have particularities that are not comparable e.g.:

- The GPS scope of military operations includes multiple dimensions that are not included in the Galileo project, cf. the table below. GPS system for instance includes larger satellites and a range of military functions that is not applicable in the Galileo project which is one of the reasons why the GPS system has been significantly more expensive than the Galileo project.

- Also it should be noted that GPS was developed long time before Galileo.

[40] It has been the working method to compile available information and to have the estimates given in these documents discussed with some of the experts interviewed for this evaluation (see Annex 1 for list of experts interviewed). The following articles have been consulted: *'GPS History, Chronology, and Budgets'* (year) by RAND Corporation

With the above reservations in mind, the comparison of development and construction costs of the two systems are presented in the below table.

Table 4.4 Development and deployment costs (Billion EUR, 2000-prices)

	GPS	**Galileo**
Expected Investment cost	In the range of 10 - 14 billion $ depending on sources of information consulted	3.6 billion EUR
Over the period	74 - 1997	2001 - 2010
	WASS not included Launch of satellites not included Additional to Galileo: • NDS Nuclear Detection • System Radiation Protection • System Star War installations	EGNOS not included Launch of satellites included

Estimates of the development and construction cost of GPS varies significantly, depending on time period included and dimensions included. The authors state that there is no an authoritative cost estimate which obviously makes a comparison with Galileo difficult.

The experts consulted for this evaluation have considered that it is not possible to compare the development costs of the two systems of the reasons stated above.

Text box 7 The history of GPS

GPS was born as a military tool. In 1993, 2 decades after it was conceived in the Pentagon, GPS became fully functional with the launching of its 24th satellite. The satellites are operated by the U.S. Air Force, which monitors them from five stations around the world. The Pentagon made the GPS system available for commercial use only after being pressured by the companies that built the equipment and saw the enormous potential market for it. As a compromise, however, the Pentagon initiated a policy known as selective availability, whereby the most accurate signals broadcast by GPS satellites would be reserved strictly for military and other authorized users.

4.5 Conclusions

- The GJU was set-up by EU and ESA as a new organisational concept to run the everyday project implementation of the development and validation phase. As a particular structure - with the following characteristics: i) temporary, ii) management body, iii) complexity-reduction - the GJU has been efficient in the management of the Development and Validation phase. The model is now being used in other contexts.

- At an early stage it was decided by the Transport Council to establish a public-private partnership with a private concessionaire to manage the Galileo system. Measured against 'ideal' criteria for PPP processes, the process of selecting the concessionaire has been partly successful. Due to the limited number of providers of the necessary technology within Europe, and the difficulties of forecasting revenues, full competition could not be sustained until contract close. Accordingly negotiated procedure was recommended for the procurement of the concession. Risk allocation is still unclear at this late stage of contract negotiation. The GJU did not develop a Public Sector Comparator until late in the process.

- A series of satellites were launched to finalise the technological developments and to ensure the large scale demonstration of capabilities and reliability of the system. The role of GJU was to conclude an agreement with ESA who will carry out the activities and furthermore to administrate and carry out financial control. Thus the overall aims of the development and in orbit validation phase has been achieved or are on track, despite political difficulties and requirements of design changes. Overall GJU is credited for its part in this process on administration and financial control, however, this task alone would probably not justify setting up a joint undertaking.

- The EU's 6th Framework Programme was meant to develop the user segment of Galileo. The task of administrative and financial management of the whole cycle of the calls of proposals was entrusted to GJU. Over a 4 year period, the GJU has been preparing, launching, selecting, managing and monitoring 3 calls for proposal resulting in a total expected co-financing of 110 Million Euro. Selected activities of the first call are almost completed and all activities of the second acc are on-going. User applications and receivers have been developed opening potential private sector opportunities for EGNOS and Galileo. The same activities could have been done internally in DGTREN but the fact that the 6FP activities have been managed and technically monitored by dedicated and specialised GNSS experts within the GJU contributed to the efficient and timely achievement of this task.

- It is found to be correct to entrust the administrative and financial management of EU contributions to EGNOS to the GJU when the EU decided to integrate EGNOS into Galileo due to the skills and experience available within the GJU. The GJU acted efficiently as it initiated and carried out all the tasks requested by the Council. Most of them are still on-going.

- The cost of the development and validation phase increased from 1,100 M€ to 1,500 M€ (37%) in the course of implementation due to design changes, delays and cost increases. According to conventional planning practices, the level of cost overrun is very low as the cost increase mostly can be explained with reference to events occurring outside of the project. The cost increase can also be interpreted according to the 'optimism bias' school of planning leading to the conclusion that the cost increase of 402 M€ should be seen as a cost overrun.

- Since project launch, the budgeted cost of the entire Galileo project has been relatively constant. Currently, the development and deployment cost of GNSS - covering EGNOS (616 M€) and Galileo (3,600 M€) - is expected to amount to 4,216 M€ for which the EU TEN-T contribution over the 2001-2006 period will amount to 823 M€. However, ultimately, the EU contribution to the Galileo project will depend also on the outcome of the concession agreement negotiations for which there is still no conclusion.

- A preliminary comparison of the development costs of Galileo with GPS development costs was initiated as part of the evaluation; however with the results that a comparison for a variety of reasons cannot be undertaken in a meaningful manner within the scope of the evaluation. The GPS system, being the first satellite navigation system to be developed, was significantly more costly to develop than the Galileo system but it includes also several military components.

5 Impact, Sustainability, Consistency

Purpose of chapter

A mid-term evaluation cannot provide precise answers to the evaluation themes of impact and sustainability which by definition shall be analysed some time after an intervention has ended. Nevertheless, it is possible to make preliminary observations on impact, sustainability and the consistency with other policies.

5.1 Impact

Impacts of an initial nature

The impact of a project describes the effects of an intervention on society. For the Galileo project, the effects will not materialise before the system becomes operational. However, the evaluation can present four initial impacts:

- **Management and organisation**. The development of a novel organisation form - the Joint Undertaking concept - is being copied and applied to other projects characterised by their institutional complexity and the need to ensure responsibility within a flexible entity. GJU has thus, organisationally, been an innovation with far-reaching consequences as the model is being copied for use in other situations. This is certainly an impact that was not foreseen.

- **Cooperation between EU Commission and ESA**. Historically, ESA has had little to do with the EU and the project has been a learning process in relation to cooperation between the two institutions where it has been necessary for the persons involved to recognise the different natures and core responsibilities of the two institutions. In the course of the evaluation it has often been mentioned that the common experience of the Galileo project will be useful with regards to future cooperation between the two institutions, e.g. in matters relating to the development of the EU Space Policy.

5.2 Sustainability

Sustainability is the extent to which the positive effects are likely to last after an intervention has terminated. This chapter considers the sustainability of the achievements of the Development and Validation phase, cf. the below table.

Table 5.1 Sustainability of main achievements of the Development and Validation phase

Objectives of the Development and Validation phase	Level of sustainability
Agreement with USA on interoperability of GPS and Galileo	High. Political prestige invested in the agreement from both sides.[41]
The definition of services offered	High. The service definition has remained constant over time.
Confirmation that there will be significant contribution from the private sector, including PPP process	Cannot be assessed before outcome of negotiations are known.
Structures for the management of the system	High. The GSA is operating.

High level of sustainability

Overall, the sustainability is high, and this is also to be expected since the main activities of the Development and Validation phase, obviously, are planned so as to deliver outputs that will be used in the subsequent phases.

The USA agreement was signed with high-level political commitment, and the interoperability of the two systems will be sustained. The overall service definitions is likewise maintained and a high level of sustainability also is found on the future organisation set-up in the form of the establishment of GSA. A remaining, possibly problematic, factor is the sustainability of the PPP agreement. A judgement cannot be made as the outcome of ongoing negotiations is not yet known.

5.3 Consistency with other EU Policies

This section aims at determining to which degree the realisation of the Galileo project will support and contribute to the fulfilment of the objectives of the following key EU policies/strategies: the Lisbon Strategy, Sustainable Development strategy, the Transport Policy and the Space Policy.

It is currently not possible to measure the final outcome and impact of Galileo on the other policies. Instead for each policy area indicators have been proposed that can be used in the future to check for consistency.

Lisbon Strategy

The Lisbon Strategy was reviewed during the Spring European Council March 2005, in which EU leaders agreed on the renewed Lisbon Strategy prioritising growth and jobs. The Commission 2006 Annual Progress Report on the Lisbon Strategy "Time to move up a gear" further identifies four priority actions, being: investment in education, research and innovation; freeing up SMEs; em-

[41] US Secretary of State Colin Powell, for instance, hailed the U.S.-EU agreement on Global Positioning System (GPS)-Galileo cooperation as a 'remarkable achievement' at a signing ceremony June 26 in Shannon, Ireland, during a U.S.-EU Summit.

ployment policies to get people into work; and guaranteeing a secure and sustainable energy supply. The European Parliament fully supports Galileo and in a resolution dated 29 January 2004, stresses "the enormous significance of Galileo for the European Union's industrial, transport, technological and environmental development, and hence at the same time for the achievement of the strategic goals set in Lisbon… "

Galileo has technological, political and economic dimensions related to the Lisbon strategy. All sectors of the economy and society are affected by the development of Galileo. Further the development of EGNOS and of Galileo has increased incitement for expansion of the application industry related to satellite navigation and according to estimates, the related application industry is growing at an annual rate of 25% and the number of jobs created as a result of the Galileo programme should be in the region of 100,000.[42]

In conclusion it is found that the Galileo project has a high level of consistency with the Lisbon strategy in aiming at creating growth and jobs through investment in research and innovation and creating employment.

An indicator of Galileo compliance with Lisbon Strategy could be turnover and employment in business linked to Galileo technology[43].

Sustainable Development Strategy

The EU's Sustainable Development Strategy 2005-2010[44] aims to bring about a high level of environmental protection, social equity and cohesion, economic prosperity and active promotion of sustainable development worldwide. Given the inter-linkages between Sustainable Development Strategy and the Lisbon strategy it not surprising that Galileo also supports several actions proposed by the Commission in its reviewed strategy for Sustainable Development.

In addition to the growth and jobs issues described under the Lisbon Strategy Galileo also provides benefits in the transport sector and innovations within satellite technology is directly addressed under actions related to sustainable transport. Also Galileo will be a useful tool for environmental monitoring reductions risks (ex. transport of dangerous goods) as well as having potential for regional development in third countries (e.g. expansion of Egnos to Africa).

Numerous applications and uses of Galileo hand some of these should be mentioned here being directly beneficial sustainable development: agriculture and fisheries (precision, monitoring etc.), energy sector (energy infrastructure, power distribution etc.), improvement of maritime and rail navigation.

It is assessed that depending on usage Galileo can have a high contribution to Sustainable Development, not only in the EU, but globally.

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[42] Communication 14.07.2004 COM(2004) 477 final

[43] DG TREN INDIC report September 2004

[44] COM(2005) 658 final, 13.12.2005: Communication from the Commission to the Council and the European Parliament - On the review of the Sustainable Development Strategy - A platform for action

Indicators are as Lisbon above plus improved environmental monitoring, reduction in emissions from transport sector.

Transport Policy

Satellite navigation systems are an integral part of the 2001 White Paper on transport "Time to Decide". The paper states the motive of having an independent satellite navigation system reducing the reliance on GPS and Glonas. The transport uses of satellite navigation are vast, covering all sectors e.g. road, rail, maritime and aviation sectors. The more significant types of use in transport are related to road navigation, freight management, ratification of infrastructures and transport safety.

Galileo receives its EU funding through the TEN T budget illustrating the close connection with the transport sector. However, from 2007 Galileo will have its own budget line.

Indicators could be reduction in congestion and reduction of accidents and especially fatalities due to more rapid and effective emergency service[45].

EU Space Policy[46]

Galileo has had a significant effect on the development of an EU Space Policy both in terms of industrial space programme and the reorientation of research programmes.

The 2003 White Paper on EU Space Policy aims to explore the benefits of space technologies, to support EU policies and objectives and achieve faster economic growth, job creation and industrial competitiveness, enlargement and cohesion, sustainable development and security and defence. The paper calls for increased funding and expenditure to develop space technology, infrastructures and applications and to support research and development within this field in line with the Galileo project. Europe already possesses many capabilities to develop services and applications related to space industry. However, if the EU does not continue its commitment to have an active policy within this area it is foreseen to lose competitiveness and market share in this sector.

Indicators could be the turnover of European based space industry, research budget available to European space industry and turnover in Galileo application industry.

Other policies

Galileo may be consistent or inconsistent with other EU policies, such as agriculture, civil right, health, banking sector, etc. However it is not dealt with here in greater detail as it is linked to Galileo through the use of the system and particularly applications and therefore relates to satellite navigation in general and also GPS.

Summary of findings

Overall, Galileo is found to have the potential to be consistent with other EU policies. The Lisbon and Sustainable Development Strategies and the Transport and Space policies explicitly describe Galileo or the use of satellite navigation

[45] DG TREN INDIC report September 2004
[46] COM (2003) 673 of 11.11.2003

technology as a tool to tackle the identified barriers within these policies and strategies.

Table 5.2 Overview and summary of findings

Policy Area	Expected level of consistency	Indicators to be used to measure consistency
Lisbon Strategy on employment, economic reform and social cohesion[47]	EU revised strategy addresses investments in technology and Galileo expectations ids development of possibly 100.000 jobs	Turnover and employment in business linked to Galileo technology
Sustainable Development Strategy 2005-2010	EU revised strategy refers to Galileo particularly in the field of environmental monitoring	As Lisbon + improved environmental monitoring, reduction in emissions
Transport Policy - 2001 White Paper	Galileo is defined within the 2001 White Paper on Transport an is therefore integral with transport policy	Indicators could be reduction in congestion and reduction of accidents and especially fatalities due to more rapid and effective emergency service
Space policy - 2003 EU White Paper on	Galileo will and have already contributed to research and turnover in the European space industry both with regards to satellites, launching and applications	Turnover of European based space industry, research budget available to European space industry and turnover in Galileo application industry

5.4 Conclusion

- A judgement on the impact of the Galileo project can be given only after the system has been in operation for a few years. Some initial impacts can be observed; the most significant one being the impact of the Joint Undertaking organisational model.

- The consistency of the Galileo project with 'neighbouring policies' has been reviewed preliminarily to be high and indicators suitable for checking consistency with policies have been suggested.

- The sustainability of the main achievements of the Development and Validation phase is high, with the exemption that the result of the PPP process in unknown.

[47] Launched by the Lisbon Council in March 2000 and revised at the Spring European Council March 2005

6 Conclusion

This *Mid-term evaluation of the Galileo project for the period 2002-2004* has had the aim of evaluating the implementation of the development and validation phase of Galileo during the period 2002-2004. In order to do so, it has been necessary to acquire a broader understanding of the entire Galileo project, and parts of the evaluation therefore cover the entire project.

The evaluation is organised so as to answer ten specific evaluation questions that were established in the inception phase of the evaluation. The conclusions in this chapter answer these questions and the chapter also provides a broader reflection on the evaluation results.

On effectiveness

The objectives

Evaluation question 1: What are the objectives of Galileo, and in particular the objectives of the development and validation phase?

The overall objective of the Galileo project is to establish a global navigation satellite system based on the following principles: primarily for civilian use, offering a broad range of services, being a significant quality-improvement compared to the GPS-system, and should involve public-private partnerships. The Galileo project is motivated by political, economic and technological potentials that in total create a richly faceted argumentation which many different actors can accept.

Level of goal-fulfilment

Evaluation question 2: To what extent have the objectives of the development and validation phase been met?

The level of goal fulfilment of the Development and Validation phase is, overall, high. Three out of four tasks (USA-agreement, service definition, and future regulatory structures) are successfully completed while the public-private partnership, being the fourth task, is not yet completed. Significant progress is being made in negotiating terms with the Merged Consortium but conclusions on risk allocation have not yet been achieved.

International agreements

Evaluation question 3: How effective has the process of concluding international agreements been, and what factors explain that is has been possible to conclude several important agreements in a relative short period of time?

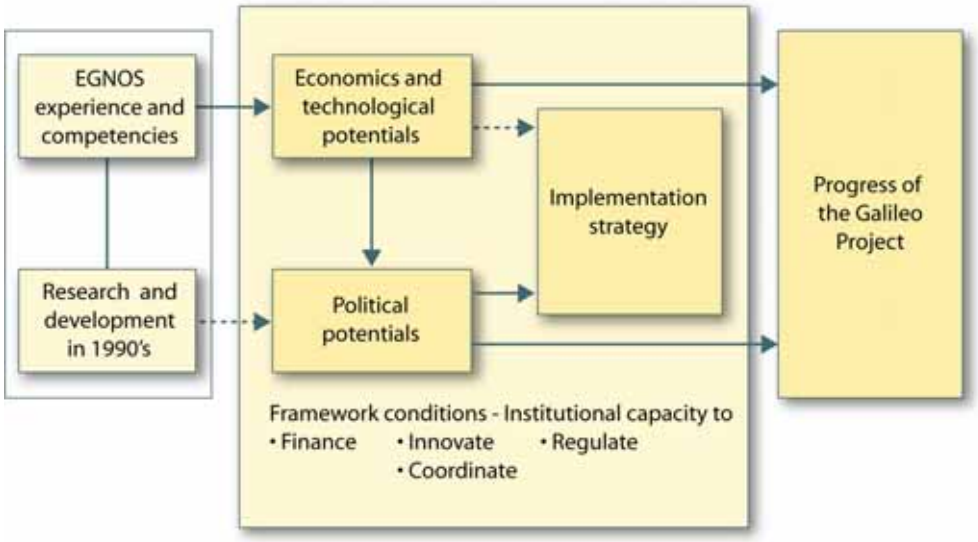
The process of concluding international agreements has been successful as several countries are committing themselves to be future users of Galileo. For the EU it was particularly important to secure third country agreements, Galileo being a new system introduced. Market access and definition of standards are crucial. The interest of third countries has also been sparked by the potential of developing high tech navigation research and industry including the potential creation of jobs. To facilitate international agreements, the EU established a framework for negotiations comprising criteria and priorities for negotiation and an overall content of agreement

Explaining the progress

Evaluation question 4: Which factors explain the successful implementation of the development phase in terms of commitment, delivery and progress?

A combination of factors has been decisive in moving the Galileo project from idea to plan to reality, cf. the figure below.

Figure 6.1 Explaining the progress of Galileo project



In particular, the political and economic potentials of the Galileo project have been important drivers. As these potentials became still more documented and accepted it was of crucial importance to develop an effective implementation strategy. The strategy was prepared and applied and became thereafter a factor in if self of importance for progress. The above-mentioned factors were effective because of the institutional framework which provided finance, regulation, innovation and coordination.

On efficiency

The GJU model

Evaluation question 5: Has the GJU, as a particular organisational structure, been efficient in the management of the development phase?

As noted in relevant EU Commission Communications and articles on Galileo and also orally expressed by experts interviewed for this evaluation, the Galileo project is a special project in terms of technological, political and institutional

complexity. The project execution is therefore requiring effective coordination and cooperation between the key actors involved; DG TREN, ESA, and the Galileo Joint Undertaking (GJU). The GJU was set-up by EU and ESA as a new organisational concept to run the everyday project implementation of the development and validation phase. As a particular structure - with the following characteristics: i) temporary, ii) management body, iii) complexity-reduction - the GJU has been efficient in the management of the Development and Validation phase. The model is now being used in other contexts.

Efficiency of GJU

Evaluation question 6: Has the GJU been efficient in meeting its specific objectives?

6.1 In overseeing the establishment of a PPP?

At an early stage it was decided by the Transport Council to establish a public-private partnership with a private concessionaire to manage the Galileo system. Measured against 'ideal' criteria for PPP processes, the process of selecting the concessionaire has been partly successful. Due to the limited number of providers of the necessary technology within Europe, and the difficulties of forecasting revenues, full competition could not be sustained until contract close. Accordingly *negotiated procedure* was recommended for the procurement of the concession. Risk allocation is still unclear at this late stage of contract negotiation. The GJU did not develop a Public Sector Comparator until late in the process.

6.2. In preparing first series of satellites to test reliability of Galileo system?

A series of satellites were launched to finalise the technological developments and to ensure the large scale demonstration of capabilities and reliability of the system. The role of GJU was to conclude an agreement with ESA who will carry out the activities and furthermore to administrate and carry out financial control. Thus the overall aims of the development and in orbit validation phase has been achieved or are on track, despite political difficulties and requirements of design changes. Overall GJU is credited for its part in this process on administration and financial control, however, this task alone would probably not justify setting up a joint undertaking.

6.3 In management of projects under the EU's 6th Framework Programme?

The 6FP contributions were meant to develop the user segment of Galilleo. The task of administrative and financial management of the whole cycle of the calls of proposals was entrusted to GJU. Over a 4 year period, the GJU has been preparing, launching, selecting, managing and monitoring 3 calls for proposal resulting in a total expected co-financing of 110 Million Euro. Selected activities of the first call are almost completed and all activities of the second acc are ongoing. User applications and receivers have been developed opening potential private sector opportunities for EGNOS and Galileo. The same activities could have been done internally in DG TREN but the fact that the 6FP activities have been managed and technically monitored by dedicated and specialised GNSS experts within the GJU contributed to the efficient and timely achievement of this task.

6.4 In managing the integration of EGNOS into Galileo?

It is found to be correct to entrust the administrative and financial management of EU contributions to EGNOS to the GJU when the EU decided to integrate EGNOS into Galileo due to the skills and experience available within the GJU. The GJU acted efficiently as it initiated and carried out all the tasks requested by the Council. Most of them are still on-going but achievements are expected in a year or 2.

Level of cost overrun

Evaluation question 7: What is the level of cost overrun of the development and validation phase?

The cost of the development and validation phase increased from 1,100 M€ to 1,500 M€ (37%) in the course of implementation due to design changes, delays and cost increases. According to conventional planning practices, the level of cost overrun is very low as the cost increase mostly can be explained with reference to events occurring outside of the project. The cost increase can also be interpreted according to the 'optimism bias' school of planning leading to the conclusion that the cost increase of 402 M€ should be seen as a cost overrun.

Since project launch, the budgeted cost of the entire Galileo project has been relatively constant. Currently, the development and deployment cost of GNSS - covering EGNOS (616 M€) and Galileo (3,600 M€) - is expected to amount to 4,216 M€ for which the EU TEN-T contribution over the 2001-2006 period will amount to 823 M€. However, ultimately, the EU contribution to the Galileo project will depend also on the outcome of the concession agreement negotiations for which there is still no conclusion.

Comparing with GPS?

A preliminary comparison of the development costs of Galileo with GPS development costs was initiated as part of the evaluation; however with the results that a comparison for a variety of reasons cannot be undertaken in a meaningful manner within the scope of the evaluation. The GPS system, being the first satellite navigation system to be developed, was significantly more costly to develop than the Galileo system but it includes also several military components.

On impact

Impact

Evaluation question 8: What will be the likely impact of Galileo and in particular the impact of the development and validation phase?

A judgement on the impact of the Galileo project can be given only after the system has been in operation for a few years. Some initial impacts can be observed; the most significant one being the impact of the Joint Undertaking organisational model.

On sustainability

Sustainability

Evaluation question 9: To what extent will the results generated in the Development and Validation phase be used in the subsequent phase?

The sustainability of the main achievements of the Development and Validation phase is high, with the exemption that the result of the PPP process in unknown.

On consistency

Consistency

Evaluation question 10: To what extent is the Galileo project consistent with other key EU policies?

Galileo is found to be consistent with other main EU policies e.g. the Lisbon Strategy and Sustainable Development strategies and being integral part of both Transport Policy and a pillar of European Space Policy. It is premature to measure the final outcome and impact of Galileo on the other policies as it will first be operational by 2010 however for each policy area indicators have been proposed based on Strategies and White Papers.

7 Recommendations

In the light of the evaluation findings, the following recommendations have been made for consideration in the future implementation of the Galileo project and related projects:

- **Lessons learned.** It is concluded that the progress of the Galileo project has been good, and that the progress is due to, among other factors, the implementation strategy applied. It should be considered how to make best use of the experience gained by planning and implementing the Galileo project. The experience of the Galileo planning process might useful to consider in the preparation of the large technological and growth initiatives wherein Europe wants to have a leading role in the near future (SESAR, ITER….).

- **Reference forecasting**. Mega-projects are notoriously difficult to budget. Although the Galileo project has been relatively successful in that respect, it should nevertheless be considered to apply reference forecasting for projects of a similar character to avoid cost overrun. Also other methods that are developed in the wake of recent years' increasing focus on optimism bias in mega-projects planning can be suggested.

- **Monitor consistency with EU policies.** It is suggested to establish indicator and collect statistics at EU level (if not already available) to measure the impact of Galileo once operational particularly related to turnover and employment in Galileo related industries and markets etc.

- **PPP**. It is recommend to enhance the supervision of the concession process in the final stages to ensure fair conditions for the public sector (and perhaps private) given that there is only one concessionaire left.

- **Homepages and access to information.** The Galileo project homepages hosted by DG TREN, GJU and ESA provides a wealth of useful information on the Galileo project targeted a wide audience. It is recommended to update the homepages as follows:

    - the DG TREN homepage
        - provide an updated time schedule (avoiding statements like 'GALILEO will be fully operable in 2008 at the latest')

  - make explicit statements and explanations on satellite navigation systems and privacy concerns, e.g. likelihood of the Galileo system to be misused, thereby adding to the legitimacy of the system

- The GJU homepage
  - provide more information on the costs and budgets (easy to understand breakdown of budgets)
  - make progress reporting to the Commission available.

- **Keeping the momentum.** Taking into account the experience gained by the GJU and the progresses made to date, it appears important to achieve a smooth transfer of GJU activities to a GSA with adequate staffing and budget.

Appendix 1 Persons interviews

Name	Authority, organisation
Olivier Onidi	DG TREN
Catherine Kavvada	DG TREN
Paul Flament	DG TREN
Eero Ailio	DG TREN
Luc Tytgat	DG Enterprise
René Oosterlinck	European Space Agency
Didier Faivre	European Space Agency
Olivier Meert	Galileo Joint Undertaking
Rui Tarraco Margalha	Galileo Joint Undertaking
Francisco Salabert	Galileo Joint Undertaking

Appendix 2 Materials consulted

In the below, the materials consulted are grouped into four categories; namely:

- Council conclusion on Galileo
- EU Commission Communications on Galileo
- Homepages
- Articles and reports

Council conclusions on Galileo:

- 10.12.2004. Conclusion of the Transport Council
- 10.07.2004 Conclusions of the Transport Council
- 15.07.2004Press release "New Funding for the trans-European energy and transport networks, Galileo and Marco Polo from 2007 to 2013"
- Proposal for a EUROPEAN PARLIAMENT AND COUNCIL REGULATION on the implementation of the deployment and commercial operating phases of the European programme of satellite radio navigation COM (2004) 477
- 12.07.2004 Council regulation (EC) No 1321/2004 of 12 July 2004 on the establishment of structures for the management of the European satellite radio-navigation programmes
- 07.07.2004. Draft Council Joint Action on aspects of the operation of the European satellite radio navigation system affecting the security of the European Union
- 18.06.2004. European Global Navigation Satellite System (GNSS). Council conclusions-
- 31.07.2003. Proposal for a Council Regulation on the establishment of structures for the management of the European satellite radio navigation programme
- 05.06.2003. Council Conclusions on the integration of the EGNOS programme in the Galileo programme.
- 05.12.2002. Council Conclusions on Galileo
- 28.05.2002. Council Regulation (EC) No 876/2002 of May 2002 setting up the Galileo Joint Undertaking.
- 26.03.2002. Council Conclusions on GALILEO
- 05.04.2001. Council Resolution on Galileo.

EU Commission Communications on Galileo

- 07.10.2004. Communication (2004) 636: Moving to the deployment and operational phases of the European satellite radio-navigation programme
- 19.02.2004. Commission Communication to the European Parliament and the Council " Progress report on the GALILEO research programme as at the beginning of 2004"
- 23.04.2003. Commission Communication: Developing the trans-European transport network: Innovative funding solutions - Interoperability of electronic toll collection systems - Proposal for a Directive of the European Parliament and of the Council on the widespread introduction and interoperability of electronic road toll systems in the Community
- 19.03.2003. Commission Communication to the European Parliament and the Council: Integration of the EGNOS programme in the Galileo programme
- 24.09.2002. Commission Communication to the European Parliament and the Council: State of progress of the Galileo programme
- 05.12.2001. Commission Working Document: Progress report on the GALILEO programme
- 22.11.2000. Commission Communication to the Council and the European Parliament on GALILEO
- 10.02.1999. Commission Communication: GALILEO - Involving Europe ina new Generation of Satellite Navigation Services
- European Commission; Press releases relating to the Galileo project
- European Commission; COM (2005) XXXXX. Communication from the Commission to the Council on the project to develop the new generation European air traffic management system (SESAR) and the establishment of the SESAR Joint Undertaking.

Homepages

- DG TREN on Galileo: http://ec.europa.eu/comm/dgs/energy_transport/galileo/intro/index_en.htm
- ESA on Galileo: http://www.esa.int/esaNA/index.html
- Galileo Joint Undertaking: http://www.galileoju.com/page.cfm?voce=m&idvoce=301&plugIn=1

Articles and report

Flyvbjerg, Bent & Nils Bruzelius, and Werner Rothengatter (2003) Megaprojects and Risk: An Anatomy of Ambition

Flyvbjerg, Bent & COWI A/S (2004) Procedures for Dealing with Optimum Bias in Transport Planning: Guidance Document, for UK Department for Transport.

Galileo Joint Undertaking (2005) GJU analysis of the IOV phase additional costs and financial needs as presented by ESA, 22nd June 2005, version 4.

Lembke, Johan (2001) The Politics of Galileo, European Union Center, Center for West European Studies, European Policy Paper No. 7.

Pasco, Xavier (2006). Galileo: A cornerstone of the European Space Effort, Commentary, to be found at the homepage of the Eisenhower Institute, http://www.eisenhowerinstitute.org/index.htm

PriceWaterhouse Coopers (2001) Inception Study for the Galileo Business Plan

PriceWaterhouse Coopers (2003) Galileo Study Phase II Executive Summary

Appendix 3 Data and benchmarks

	Evaluation question	Data sources used (most important = bold)	Benchmark used to arrive at a judgement
1	What are the objectives of Galileo, and in particular the objectives of the development and validation phase	**Formal documents (Communications and Council Decisions)** Reports, articles and studies on Galileo Interviews Other relevant topic literature Evaluator's own assessment	No benchmark as such. Formal documents used to extract hierarchy of objectives.
2	To what extent have the objectives of been met?	**Formal documents (Communications and Council Decisions)** Reports, articles and studies on Galileo **Interviews** Other relevant topic literature Evaluator's own assessment	Compare level of achievements with the formal documents describing the objectives
3	How effective has the process of concluding international agreements been, and what factors explain that is has been possible to conclude several important agreements in a relative short period of time?	**Formal documents (Communications and Council Decisions)** Reports, articles and studies on Galileo **Interviews** Other relevant topic literature Evaluator's own assessment	Compare achieved outcome with the initial expectations
4	Which factors explain the successful implementation of the development phase in terms of commitment, delivery and progress?	Formal documents (Communications and Council Decisions) **Reports, articles and studies on Galileo** **Interviews** Other relevant topic literature **Evaluator's own assessment**	No benchmark used. Instead an analytical description is set forth on the basis of hypotheses. An assessment is made of the plausibility of the hypotheses
5	Has the GJU, as a particular organisational structure, been efficient in the management of the development phase?	Formal documents (Communications and Council Decisions) Reports, articles and studies on Galileo **Interviews** Other relevant topic literature **Evaluator's own assessment**	i) Compare whether an alternative set-up could have been more efficient (counter-factual description) ii) Analyse whether the JU as a model will be reproduced, i.e. will be used for other purposes, thereby indicating its general potentials
6	Has the GJU been efficient in	see below	See below

	Evaluation question	Data sources used (most important = bold)	Benchmark used to arrive at a judgement
	meeting its specific objectives:		
6.1	in overseeing the establishment of a public private partnership between the public and the private sector in order to manage the Galileo Programme and mobilise the required funds?	Formal documents (Communications and Council Decisions) **Reports, articles and studies on Galileo** **Interviews** Other relevant topic literature Evaluator's own assessment	Compare Galileo PPP process with generally accepted criteria for the planning of a PPP process (The PWC Business case study and internal DG TREN guidelines)
6.2	in preparing through ESA a first series of satellites to ensure the large-scale demonstration of the capabilities and reliability of the Galileo system?	Formal documents (Communications and Council Decisions) Reports, articles and studies on Galileo Interviews Other relevant topic literature Evaluator's own assessment	No benchmark available
6.3	in management of projects launched under the EU's 6th Framework Programme)	Formal documents (Communications and Council Decisions) Reports, articles and studies on Galileo Interviews Other relevant topic literature Evaluator's own assessment	No benchmark available
6.4	In managing the integration of EGNOS into Galileo.	Formal documents (Communications and Council Decisions) Reports, articles and studies on Galileo Interviews Other relevant topic literature Evaluator's own assessment	No clear benchmark available Compare with objectives given by Council decision
7	What is the level of cost overrun of the development and validation phase?	**Formal documents (Communications and Council Decisions)** **Reports, articles and studies on Galileo** Interviews **Other relevant topic literature** Evaluator's own assessment	Compare observed cost-overrun level with the cost overrun level of a sample of international large-scale projects (Literature on optimism bias)
8	What will be the likely impact of Galileo and in particular the impact	**Formal documents (Communications and Council**	Comparing the anticipated impact (as described in formal documents)

	Evaluation question	Data sources used (most important = bold)	Benchmark used to arrive at a judgement
	of the development and validation phase?	**Decisions)** **Reports, articles and studies on Galileo** **Interviews** Other relevant topic literature Evaluator's own assessment	with de-facto impact. As the impacts have not fully materialised, the assessments is based on the viewpoints of the experts interviewed on the initial impacts
9	To what extent will the results generated in the Development and Validation phase be used in the subsequent phase?	**Formal documents (Communications and Council Decisions)** Reports, articles and studies on Galileo **Interviews** Other relevant topic literature Evaluator's own assessment	Comparing list of outcome of the Development and Validation phase with planning for the Deployment Phase
10	What is the level of consistency of the Galileo with key EU policies/strategies?	**Formal documents (Communications and Council Decisions)** Reports, articles and studies on Galileo Interviews Other relevant topic literature **Evaluator's own assessment**	Compare objectives of Galileo project with objectives of key EU policies. Identify suitable indicators for future monitoring of actual consistency of Galileo with other policies.