Inception Study to Support the
Development of a Business Plan
for the GALILEO Programme

TREN/B5/23-2001

Executive Summary

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I Executive summary

1 Galileo

Galileo is a Global Navigation Satellite System promoted by the European Commission and the European Space Agency. Its rationale is:

- **Strategic:** to protect European economies from dependency on other states' systems which could deny access to civil users at any time, and to enhance safety and reliability. The only services currently available are the US Global Positioning Service (GPS) and the equivalent Russian system, both military but made available to civil users.

- **Commercial:** although Galileo will not be able to charge for the use of its basic service, because it is accepted that users need to have free open access, it could become a commercially viable business by providing value added services which will establish a position in the market alongside GPS.

- **Economic:** to secure an increased share for Europe in the equipment market and related technologies, deliver efficiency savings for industry, create social benefits through cheaper transport, reduced congestion and less pollution and stimulate employment.

We estimate the cost of the system to be Euro 3.6 billion. The EC and ESA have budgeted Euro 1.25 billion for the Development phase and application development. This leaves a balance of Euro 2.35 billion to be spent on deploying the system. This will need to be met by a combination of public sector support and private sector funding.

2 This Study

Past analysis of Galileo has been undertaken largely by groups likely to play a major role in taking Galileo forward. This study has been commissioned by the European Commission to provide an independent review of:

- the services which should be offered and the revenue which could be generated;

- the specification and cost of the system;

- the case for public and private sector investment;

- the structure for a Public Private Partnership; and

- the strategy for procuring and financing the system.

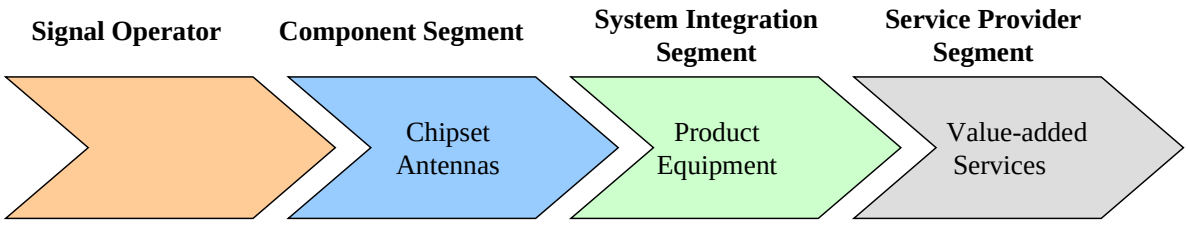
The work has been led by PricewaterhouseCoopers as financial advisers, with input from Denton Wilde Sapte on legal issues, Deutsche Bank on financial markets, Ovum on GNSS markets and services, Satel Conseil on system costs and Willis on insurance. It is based on

the proposed infrastructure and services described in the Commission's Mission High Level Definition document dated April 2001.

3 Market for Services

The core Galileo infrastructure will be a satellite constellation and ground control stations. This will be built and operated by a signal operator, the Galileo Operating Company. The Operating Company is the entity for which a Business Plan is required and around which a PPP could be created. But the viability of the system will depend on the success of other activities in the value chain. The Company will therefore need to stimulate the provision of services by other companies if it wants to establish a commercially viable operation.

Figure 1 Galileo Value Chain



The services likely to be offered are:

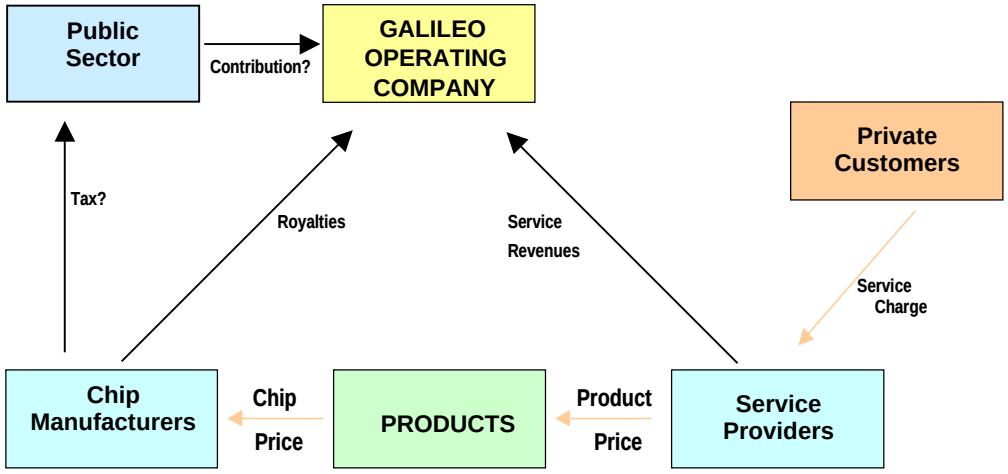
- An Open Access Service, free to all users and providing basic positioning navigation and timing signals as a new universal service
- Commercial Services based on additional encrypted data, permitting a charge to be made.
- Safety of Life Services which will provide greater accuracy and integrity, allowing the user to know within a few seconds if the positioning information has become corrupted.
- A Search and Rescue Service which identifies a user's location to civilian emergency services.
- A Public Regulated Service based on a robust signal, resistant to interference or jamming and restricted to certain public security organisations such as police and fire services.

As a result of these services the Galileo Operating Company will get revenue from:

- Royalties on chipset sales, paid by equipment providers who incorporate a Galileo chip in their products to allow users to get the Open Access Service; and
- Income from Service Providers who want to use the specialised encrypted signals to offer other services.

The security of income from chipset royalties requires detailed investigation. One possibility would be for the signal to be encrypted and for Galileo chipsets to contain copyright protected software to decode it. The EU or member states could themselves also raise revenue by imposing a tax on the sale of all Galileo and GPS terminals in Europe. This would be a way of funding the public sector contribution to the project.

Figure 2 Sources of Galileo Operating Company Revenue



The commercial case for establishing Galileo alongside GPS is that users will be willing to pay for superior services, and users of the Open Access Service should prefer a terminal that can provide better coverage and reliability by receiving both signals. But this will only be the case if cost differentials for combined access to Galileo and GPS services are small; so our base case assumes a royalty on Galileo chipsets of only 5%. This assumption conforms with the industry view that any royalty above 5% would have a negative effect on demand.

It is very important that Galileo should commence service by 2008. The market will be in a rapid growth phase by then, and GPS III (a more sophisticated version) is expected to commence operations 1 or 2 years thereafter. Galileo will only become established if it is in the market in time to gain acceptance in the launch of new equipment and services which will accompany this change. If that is achieved we estimate that the annual sale of Galileo receivers will increase from 100m in 2010 to some 875m by 2020; which represents market penetration rising from 13% to 52%.

The following table shows the revenue this would imply. Our expectations are higher than previous forecasts, largely because of the scope to charge a 5% chipset royalty (rather than 2% as assumed in the past).

Table 1 Revenue Comparison PwC v. Previous Studies

Euro m (2001 prices)	PwC			GEMINUS Study			GALA Study		
	2010	**2015**	**2020**	**2010**	**2015**	**2020**	**2010**	**2015**	**2020**
Service Revenues	6	70	200	65	125	165	25	80	305
Purchase Revenues	60	300	315	10	60	215	30	75	109
Total	**66**	**370**	**515**	**75**	**185**	**380**	**55**	**155**	**415**

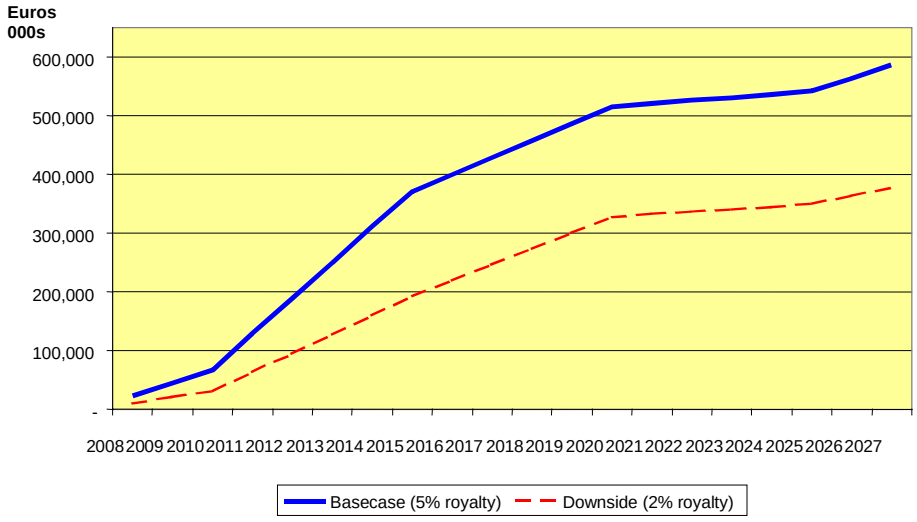
The key sources of revenue (80% of the total in 2020) should come from 5 applications. (We also considered the possibility of offering a high precision location service to mass market customers. If 2% of customers purchased this by 2020 the additional revenues could be in the region of Euro 12m a year. However this is not in our base case).

Table 2 Estimated revenues by application (Euro m 2001 prices)

Application	**2010**	**2015**	**2020**
Personal communications and location	48	276	288
Commercial Aviation	-	20	100
Police and Fire (Pedestrian resource management)	1	10	20
Oil and Gas – Rig Positioning	1	8	15
Oil and Gas – Land and transition zone seismic exploration	2	9	10
Others	14	47	82
Total	**66**	**370**	**515**

These revenues are large. But it is inevitable at this stage in development of the market that they have a high level of uncertainty. For example, Figure 3 shows a sensitivity where the royalty on chipsets is only 2%. The business plan and any PPP financing need to take account of significant downsides like this.

Figure 3 Revenue scenarios (2001 prices)



We do not see any major legislative barriers to the generation of revenues. Articles 81 and 82 of the Treaty of Rome (dealing with competition rules) are unlikely to present barriers to the charging of royalties. However, some action may be required to ensure that other legislation does not discourage use of Galileo services.

4 System and Costs

In order to provide its services the Galileo system will require Global, Regional and Local Components. The Global Component will involve:

- a constellation of 30 Medium Earth Orbit satellites probably requiring a total of 38 satellites to provide up to 8 ground spares for subsequent Deployment; and

- a ground segment to control the satellites, distribute information and provide service centres for interface with users.

Regional Components will comprise EGNOS (a European system providing integrity and differential correction through Geo-stationary satellites) and ground segments outside Europe (to provide integrity data if other regions choose to use the service but not to rely on Galileo's Global Component). Local Components will meet any requirements which are more demanding than can be met by the Global Component. Responsibility for funding the Regional and Local Components will be with service providers. We have estimated the costs for the Global Component and integration of the EGNOS system.

Table 3 shows our estimates costs on the assumption that the system is procured by the public sector through competitive tenders. The potential savings under a PPP are considered later. It compares our figures to ESA's Galileo Independent Cost Evaluation and the figures in the Commission's Mission High Level Definition.

Table 3 Development and Deployment Phase Costs

	Development (2002-5)			Deployment (2006-7)			Total		
Euro m 2001	**PwC**	**ESA**	**EC**	**PwC**	**ESA**	**EC**	**PwC**	**ESA**	**EC**
Ground segment	423	341	903*	354	471	1,840*	777	812	2,743*
Space segment	562	485		1,270	979		1,832	1,464	
ESA costs	99	83	98	55	48	62	154	131	160
Contingencies	166	91	99	170	150	198	336	241	297
Other	127	-	-	180	50	-	307	50	-
TOTAL	**1,377**	**999**	**1,100**	**2,029**	**1,698**	**2,100**	**3,406**	**2,697**	**3,200**

* Ground and space segments combined

Our estimates are broadly in line with the Commission's but are significantly higher than ESA's. This is principally because of the additional contingencies (we have allowed 15% on development costs and 10% on deployment costs, which we believe is appropriate given the levels of uncertainty inherent at the current stage of system definition), the inclusion of costs for application and market development, and the cost of procuring the additional satellites to be used as ground spares.

We believe that public funding required for the Development phase before 2005 will be about Euro 1.35 billion. This is Euro 150 million greater than currently budgeted. The total spend could be contained within the budget by reducing the number of test satellite launches from 4 to 3 and containing contingencies to a 10% level, although fewer development launches could increase the risk of poor performance.

In the Operating phase:

- Operating costs seem likely to be in the range Euro 100–120m p.a. at 2001 prices. This is somewhat higher than previous studies because we think additional spending is needed on market development.

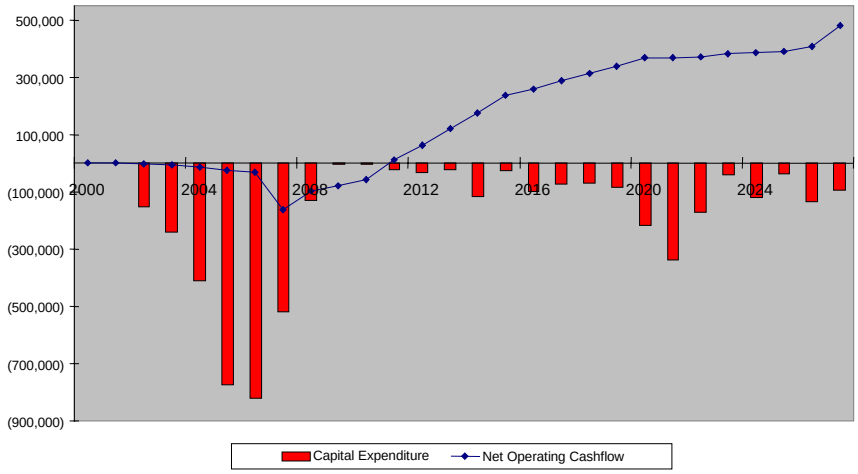
- The infrastructure will require replenishment between 2016 and 2022 costing about Euro 1.8 billion. This is broadly in line with ESA's evaluation and much lower than the EC estimate.

- Taking operating and replenishment costs together we estimate that average annual costs will be Euro 220m a year – higher than ESA's previous estimates but almost exactly the same as the EC forecast.

5 Financial Projections

Based on these costs and revenues the graph below shows our view on the likely operating cashflow and capital investment.

Figure 4 Base Case Forecast Cash Flow (Euro m 2001 Prices)



The net operating cashflow line is market revenues less operating costs. It shows that the project starts to make operating profits in 2011. But after taking account of capital expenditure the projected Internal Rate of Return of the Deployment and Operations phases of project is just 4.1% real. This is less than the cost of private capital and means that public

sector support will be needed for capital expenditure on Deployment or in the Operating phase. Private sector finance can make a contribution to the costs but only with some continuing support.

We have considered a number of scenarios and sensitivities to see whether different configurations or changes in key assumptions would improve the projections. The most important are inclusion of additional services not in the original definition, a more optimistic assumption on the timing of revenue from the aviation sector, and greater use by Police and Fire Services. However, none of the upside scenarios or sensitivities significantly changes the Internal Rate of Return of the project.

6 Cost Benefit Analysis

It is clearly necessary for member states to be satisfied that there is a robust cost-benefit case for a project of this sort, especially if it requires support not only in the Development phase but also during Deployment and Operation. We have reviewed the methodology used for the Commission's previous Cost Benefit Analysis and done new calculations based on the projection of revised costs, market take up and discount rates. Our analysis puts greater emphasis on user benefits and social benefits. We believe producer benefits - which were considered in past analyses - should be excluded as they consume resources with alternative uses.

The benefits principally arise from air traffic control, marine navigation, and route guidance for motor vehicles. The largest and most robust are generated from the aviation and maritime industries.

Table 4 Value of Main Benefits (Euro m 2000 prices)

Description of Benefit	Annual values		NPV
	2010	2020	2008-2020
Improvements in air traffic control			
cost savings for airlines	166	3,381	7,476
time savings for passengers	82	1,667	5,447
Marine navigation	81	2,638	4,864
Total	329	7,686	17,787

The previous study for the Commission implied higher total benefits of Euro 27.2 billion NPV (using our discount rates) largely because it estimated greater benefits from route guidance.

Even with these more conservative assumptions on user benefits and the exclusion of producer benefits we estimate total benefits at Euro 17.8 billion in NPV terms and costs at Euro 3.9 billion, implying a benefit:cost ratio of 4.6. This should be regarded as a strongly positive ratio. For example public sector transport projects in the UK, on the underground railway and in roads, often proceed with rations of about 3.0.

So our analysis shows that the economics of Galileo do not support investment by the private sector on purely financial criteria, but that the benefit to the European economy should be significant. The reason is a market imperfection. Many of the benefits, such as

improved efficiency in the use of airline fleets, are likely to accrue to consumers rather than be captured by the industries that use Galileo services, because competition will ensure that the value cannot realised in higher prices. Industrial users of the service will not therefore be able to increase margins to make a payment to the Galileo operator. There should however be a case for the public sector to promote Galileo if it can do so at a cost which represents value for money for the economy as a whole taking account of the wider economic and strategic benefits.

7 Structure of a Public Private Partnership

The principal objective of a PPP should be to achieve value for money for the public sector by transferring appropriate risk and responsibility to the private sector in a way which creates incentives to optimise the technical solution and cost of the system. Any PPP also needs to ensure that operations commence by 2008 in order to meet the window of opportunity in the market; optimise the benefits arising from ESA expertise in the Development phase; and bring the EC, ESA and member states together in a procurement process that the private sector believes will deliver.

There are two potential strategies for meeting these requirements:

- A Joint Venture; and
- A Concession Company.

Both involve the EC's proposed Joint Undertaking during the development phase to the end of 2005.

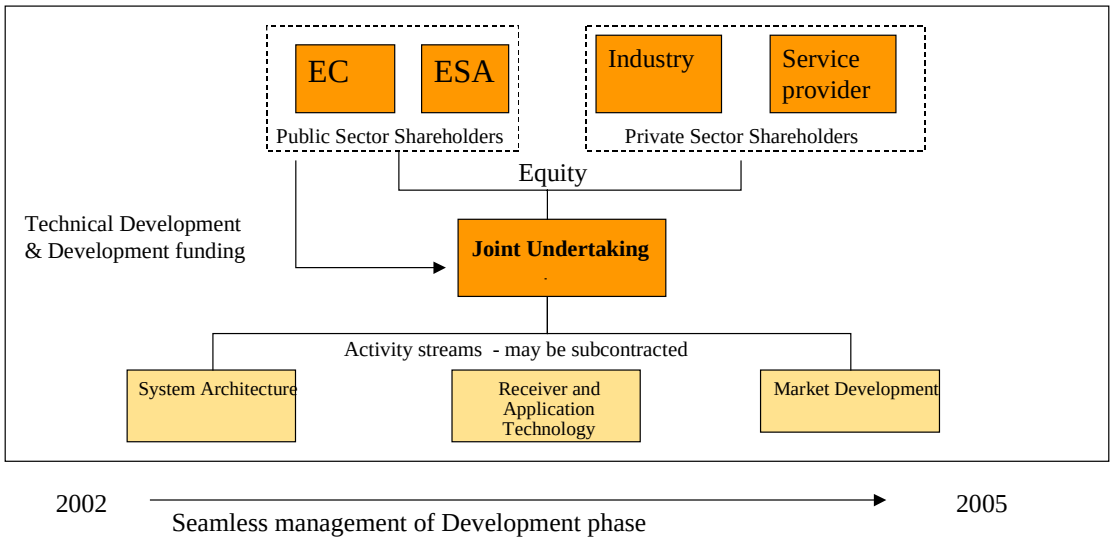
7.1 Joint Venture

The European Commission has proposed this model to European industry. The public and private sectors would jointly invest in a single entity. In the Development phase:

- The current Joint Undertaking would be the Joint Venture entity;
- ESA and the EC would hold a controlling interest in the Joint Venture;
- The Private Sector would invest equity and become minority shareholders in the Joint Venture;
- Additional public funding would be provided through in-kind assistance and grants;
- The interface between the public and private sectors would be through the management board and shareholders agreement;
- The Joint Venture would contract out various development functions as required.

This is illustrated in Figure 5.

Figure 5 JV Model Development Phase

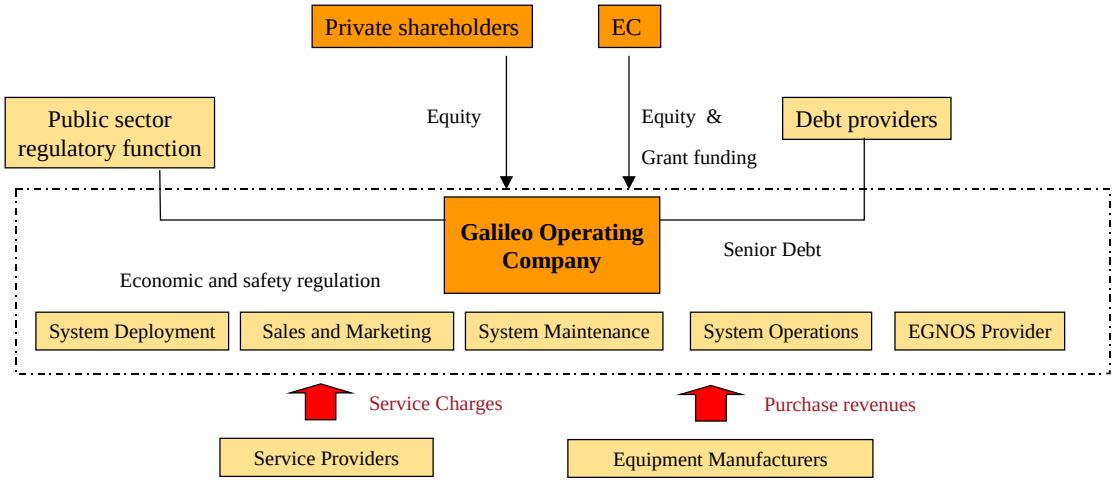


At the end of Development phase the role of the Joint Venture entity would transfer to the newly established Galileo Operating Company. In the Deployment and Operations Phases:

- The Galileo Operating Company would then create subsidiaries or let subcontracts to carry out work;
- It would be financed by public equity and grant and private equity and debt;
- It would derive revenues from the market;
- Private shareholders would be drawn from industry, service providers, institutions and (in future) the public;
- We would recommend that there should be a separate public sector function for economic and safety regulation to avoid any potential conflict between the public sectors financial interest in the Galileo Operating Company and the wider public interest role of a regulator.

This is illustrated in Figure 6.

Figure 6 JointVenture Model Deployment and Operations Phase



This Joint Venture model is a coherent way of meeting most of the public sector's objectives. But we found that the private sector is very reluctant to participate in it or invest under it. Industry does not understand how there can be a return from participation in the Development phase; and in the Deployment and Operations phases it remains concerned about insufficient profitability (because the analysis we have presented is broadly in line with industry expectations), high levels of revenue risk, very long time horizons and a potential conflict of interest for the public sector if it is both equity investor and public sponsor of the project. We do not believe this is a viable model for attracting investment.

Concession Company Model

We have developed an alternative model which would build on the expertise and knowledge developed by ESA, fulfil the objectives of the public sector and address these concerns of industry. This involves a concession which would give a clearer separation between public and private sectors and provide for the business to be supported during the operating phase by an availability charge for service provision.

- The Joint Undertaking would become a public procurement authority in 2002 and organise a competition to award a concession for Deployment and Operation of Galileo;

- The Operating Company would be a privately owned concession entity formed by the winning bidder. It would build, finance and operate the system. Its shareholders would probably be the space industry, service providers and financial institutions;

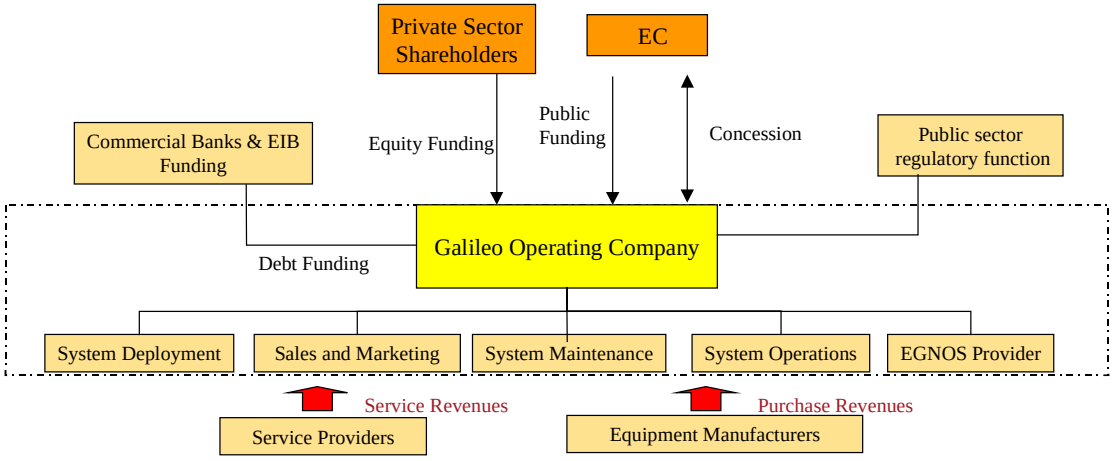
- At the end of the Development phase the Joint Undertaking would be replaced by another public entity, assumed in our report to be the EC. This would be the public sector counterparty for the remainder of the concession;

- The Operating Company would finance its activity from private equity and debt.

- The Operating Company would contract with the Joint Undertaking and then the EC to provide a level of service in return for an availability payment. There would be a formula for splitting market revenues between the Operating Company and the public sector.

- There would be a separate public regulatory function to govern safety standards and pricing for certain services.

Figure 7 The Concession Model (Development & Deployment)



There are a number of important considerations in implementing this:

- It is important to achieve market entry by 2008. A sequential PPP procurement process under which the bidders design and develop their own system and construct a business plan would not be compatible with this. So a PPP bidding process will have to proceed in parallel with ESA development work. This implies a need for interaction between bidders and the development team to ensure that the system reflects the private sector's view on market opportunities.

- In order to raise finance bidders will need to place a lump sum turnkey contract for the system as a whole with appropriate provision for penalties for late delivery. This is required to give funders confidence that system integration risks will be properly managed. Such a contract would need to be placed by 2004, overlapping with the end of the ESA managed Development phase.

- Galileo Industries, the industrial consortium formed to pursue the Galileo project, includes virtually all the European companies which could credibly act as prime contractors for the Galileo project. It already has a crucial role in the current system specification and is expected to continue in the Development phase. Generation of

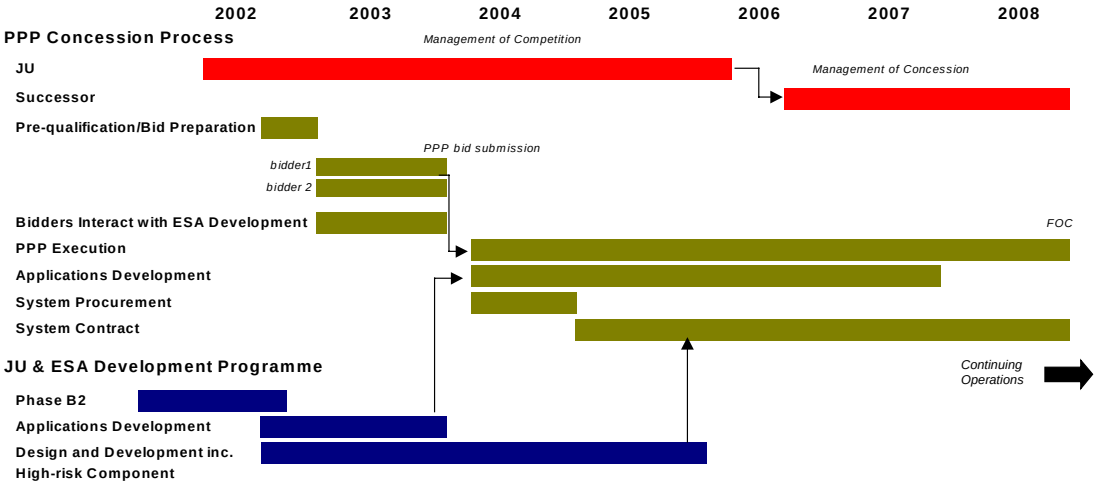
competition for procurement of the system will therefore be difficult. But this difficulty needs to be overcome because competition for development ideas and pricing is critical to getting the right outcome.

Recommended Approach

Our recommended approach for managing the PPP competition and procurement of the system contract is illustrated below. The key features are:

- The Joint Undertaking and ESA managing Development;
- The PPP concession is awarded in early 2004;
- A system contract is then awarded by the PPP concessionaire.

Figure 8 Recommended Approach to Establishing a Concession Company



The Joint Undertaking would therefore have overall responsibility for managing the PPP selection process and, through ESA, be responsible for managing the Development phase. This would give access to the expertise of ESA and maintain the existing momentum in the programme. It would allow the public sector sensible influence over the private sector in the early stages to ensure that there is no delay. But it would allow the system contract to be procured by the Operating Company after the private sector takes control, allowing them to match the system to their assessment of operational requirements.

The PPP concession would be awarded by:

- Beginning a PPP tender in early 2002 and encouraging the signatories of the Memorandum of Understanding to form competing bidding consortia

- Selecting two pre-qualified bidders to prepare tenders for meeting the specification in return for a bid availability charge;

- Involving the bidders in the design review of the system (scheduled for late 2003) and giving them access to the ESA design on which they would be required to base a standard bid;

- Giving bidders the option to submit a variant bid based on an alternative design to see if this offers a better balance between system performance and cost;

- Selecting a preferred bidder on Economically Most Advantageous criteria in early 2004 with a negotiated finalisation of price thereafter once there is a firmer appreciation of system requirements;

- Award of the PPP concession early enough to permit the successful bidder to let the system contract competitively.

ESA development work, involving testing and validation of the system and continued responsibility for certain long-lead time and high risk components where ESA contracts have already been let, would continue to the end of 2005. There would be a mechanism for the public sector to compensate the Operating Company for the cost consequences of any late design changes arising from this. ESA would have to ensure that the Development work was divided between potential system prime contracts in order to make sure that at least two potential prime contractors were in a position to bid for the system contract.

This process requires careful management and it is likely to extend the schedule for commencement of operations by about 6 months from the presently planned date of the beginning of 2008 due to the time taken to undertake the system contract procurement. But we believe this represents the appropriate way to combine the skills of the public and private sector.

8 Structure of the Concession and Availability Payment

The key characteristics of the Concession would be:

- A Concession term of up to 20 years, under which the EC would pay the operator an availability payment from commencement of commercial operations.

- The availability payment would be intended to supplement market revenue to give the company enough expected income to cover:

  - operating costs
  - debt service payments and tax; and
  - provide a degree of return to shareholders.

  However this would not be guaranteed. The company would only deliver a return if it earned its projected commercial revenue by achieving the expected market penetration,

and met performance requirements. It would also be exposed to capital and operating expenditure risk.

- There would be a mechanism for sharing upside in commercial revenues with the public sector. This could partially offset the public sector availability payment.

- There would be a break mechanism for re-negotiation of terms when the satellite constellation has to be replaced.

- The public sector would provide cover for the product liability risks above the level which could be insured commercially.

9 Financing

Our view is that, with the appropriate risk allocation, the private sector would be able to finance a significant proportion of the Deployment and Operation costs under the sort of structure used for Private Finance Initiative (PFI) projects, with up to 90% senior debt and 10% equity/quasi equity. This assumes our proposed contractual arrangements and that the counterparty to the concession would be the EC or another body with a sovereign credit. In practice, it would be for the bidders to choose the financing structure. A higher or lower level of gearing might be achieved depending on final risk allocation and the level of return the shareholders of the bidding PPP consortium are prepared to accept.

The level of private funding which is needed depends on the amount of support which the public sector is willing to make available for Deployment costs up to 2008. If support for Deployment is low then the project will only be viable with a high availability payment during the concession. If support for the Deployment costs is high then there will be less need for private capital and the availability payment during the concession can be lower. Table 5 shows the likely trade off.

Table 5 Public Funding for Deployment versus the Level of Availablility Payment (Nominal)

Additional Level of Public Funding* For Deployment	Public Funding of Deployment Costs (Euro Bn)	Private Funding of Deployment Costs (Euro Bn)	Annual Availability Payment (Euro Bn)
33%	0.80	1.60	0.39
50%	1.20	1.20	0.32
66%	1.40	0.80	0.27

*deployment costs include Euro 0.4m in excess of the Euro 1.25bn development budget

There is no basis to choose between these scenarios in purely financial terms. The NPV of the cost to the public sector could be broadly the same in each case. The decision on how to balance up-front public funding with the level of the availability payment should be made to optimise incentives for the private sector to perform and to reflect budgetary constraints in the public sector. A lower up-front contribution and a higher availability payment may achieve this.

Table 6 shows how the total funding requirement of some Euro 3.6 billion would be met and applied if the level of public contribution was 33%.

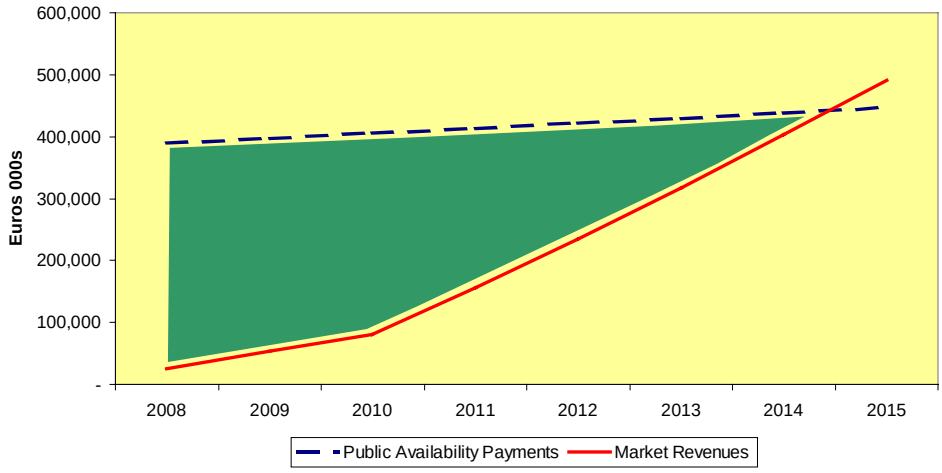
Table 6 Sources and Uses of Finance 2002-2008 (nominal)

Sources	Euro bn	Uses	Euro bn
Government Grants – Development and Applications	1.25	Capital Expenditure (Development)	1.57
		Operating Costs (Development)	0.05
Government Grants for 33% of the Balance of Costs	0.77	Applications Development (Development)	0.10
Senior Debt	1.44	Capital Expenditure (Deployment Phase	1.59
Shareholder Equity and Quasi Equity	0.16	Operating Costs (Deployment)	0.22
		Applications Development (Deployment)	0.06
		Interest & Fees	0.03
Total	**3.62**	**Total**	**3.62**

10 Availability Payments

Figure 9 below shows the level of availability payments which would be required to support private finance of Euro 1.6 billion shown in Tables 5 and 6. The shaded area indicates public sector payments starting at about Euro 350m in 2008 and declining potentially to zero by 2015 as revenues increase.

Figure 9 Availability Payments v Market Revenues (Base Case)



The NPV of the public sector contribution over the period 2008-2022 at a 5% real discount rate is Euro 0.8 billion in 2001 prices. Together with the public funding of Euro 1.2 billion in the Development Phase and Euro 0.8 billion for Deployment costs this implies a total public investment of some Euro 2.5 billion in NPV terms. On this basis the total of public and private sector costs would still be significantly below the gross economic benefits of

Euro 17.8 billion shown by our cost benefit analysis. This indicates that there remains a strong justification for the payments if the Member States accept this Business Case.

We have examined the possibility of availability payments being funded by the public sector from the proceeds of a tax or levy on Global Navigation Satellite System terminals sold in the EU. The average level of tax which would be required to accrue this is about Euro 2 per terminal. It may also be possible for national budgets of the Member States which are currently allocated to the provision of positioning and navigation services to be freed up to help pay for the Galileo availability payment. We have not been able to assess the potential for this.

11 Value for Money

In order to assess whether a PPP is Value For Money compared to traditional procurement it is necessary to prepare a Public Sector Comparator (PSC). This is a hypothetical costing by the public sector of the output specification for a PPP. It should be based on a public sector method of providing that output and take full account of the risks which the public sector encounters in procurement.

It is only ever possible to produce a preliminary and outline PSC indicator at this stage of a process. We have taken our estimates from public sector competitive procurement and looked at whether a PPP would achieve Value For Money if savings of 5% on capital costs and 10% on operating costs could be realised. This is less than has historically been achieved in completed PPP projects in the UK; but in our view it may be difficult to realise greater savings for Galileo given the constraints on competition in the Development phase. Our projections show such savings would be sufficient to deliver Value For Money from a PPP. However, at this stage it is not possible to be conclusive as both the PSC and the terms of the PPP would need to be refined as part of the procurement process.