# The Implementation of a Public-Private Partnership for Galileo

## Comparison of Galileo and Skynet 5 with other Projects

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**BIOGRAPHY**

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**ABSTRACT**

Galileo, Europe's global navigation satellite system, represents a major public infrastructure offering numerous advantages for civilian users worldwide. The public dimension combined with the significant growth of the satellite navigation markets prompted the European Union to choose a Public-Private Partnership (PPP) scheme for the deployment and operational phases of the Galileo program. After a short introduction on the fundamentals of PPP schemes, both Galileo and Skynet 5 programs are compared to other large scale PPP projects, mainly in the transport sector. It clearly appears that a strong cooperation between the public sector and industry is needed for PPPs in the space sector. The present work attempts to provide a view of the Galileo PPP from an industrial perspective and to discuss the main critical issues of its implementation: risk allocation, finance, regulatory framework and other related issues. Technical and business complexity is the key driver which determines financial aspects and risk allocation. Therefore PPPs in the space sector show unique features in comparison with other sectors.

If PPPs appear to be a complicated procurement scheme to their detractors, experience shows that behind the acronym lies a concrete collaborative work which demonstrates how the public sector and industry (private) can together achieve both market and policy success. The Galileo and Skynet 5 programs do - and will - face issues in many areas. No doubt they also provide positive experiences to be transferred to future space projects and the increasing popularity of PPPs as innovative financing schemes.

**INTRODUCTION**

Galileo is the European Global Navigation Satellite System (GNSS) which will be interoperable with the current US Global Positioning System (GPS). Unlike GPS, which is a military system, Galileo was designed primarily for civil purposes. The deployment and operation of the Galileo system will be managed by establishing a Public-Private Partnership (PPP) between industry and the Galileo Supervisory Authority (GSA) within the framework of a concession contract.

After a short introduction on the principles of PPP schemes, the present paper attempts to analyze their actual implementation in both transport and space sectors with respect to technical and business model complexity and the consequences thereof. In particular, this allows a fair comparison between already established PPP projects and Galileo, in order to highlight the specificities of space related PPPs and the associated challenges faced in implementing PPP schemes in the future.

**OVERVIEW OF PPP MODELS**

**Definition**

Although there is no widely accepted definition of Public-Private Partnerships (PPPs), these schemes are usually described as partnerships between the public sector and the private sector (industry), for the purpose of delivering a project or a service traditionally provided by the public sector.

PPPs come in a variety of different forms ranging from full public responsibility (e.g. in-house public procurement) to full private responsibility (e.g. privatization). Figure 1 provides a classification of five common PPP structures with respect to responsibility transfer between the public and the private sector.

In general PPPs are characterized by the following generic phases after contract signature until termination: financing, design finalization, construction, operation and services provision. The sequence and nature of the phases may vary substantially from one PPP to another, but in general these are the steps which are followed.

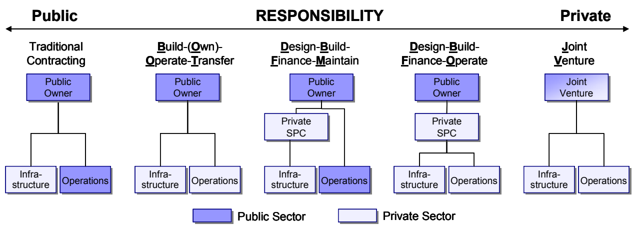


**Figure 1: PPP Types and Responsibility Transfer**

The public sector not only contracts for infrastructure development and deployment, but also for management and operations where risks are shared between the public and the private sector. In particular, some of these structures are characterized by the involvement of private finance, mainly through the establishment of Special Purpose Companies (SPCs). In Europe, the UK has been extensively developing such partnerships through so-called Private Finance Initiatives (PFI) (see DBFM and DBFO structures), a special category of PPP schemes.

PPPs can generate substantial benefits for customers and taxpayers. However, the scope of potential benefits will depend on the type of project being undertaken and the exact terms of the contract governing the PPP. In the end Value for Money (VfM) will only be achieved through the exploitation of private sector competencies, combined with an appropriate allocation of responsibilities between the public customer and the private contractor.

### Value for Money

In order to properly assess whether a PPP is Value for Money (VfM) compared to a traditional procurement, a Public Sector Comparator (PSC) is prepared to provide a basis for judging the attractiveness of PPP schemes. This is a hypothetical risk-adjusted costing by the public sector taking into account the total life-cycle costs of the project.

To be a valid benchmark against which private sector bids can be compared, the PSC must reflect not only base costs (i.e. most likely cost out-turn) but also the additional costs that may arise if risks such as delays and cost escalation materialize. Therefore the PSC must be adjusted with risks classified into two categories from a customer point of view [1]:

- **Retained Risks**, which must by definition be the same within PSC and PPP;
- **Transferred Risks**, which are included in the service payments but need to be taken into account in the PSC, with the so-called risk adjustment (see Figure 2).

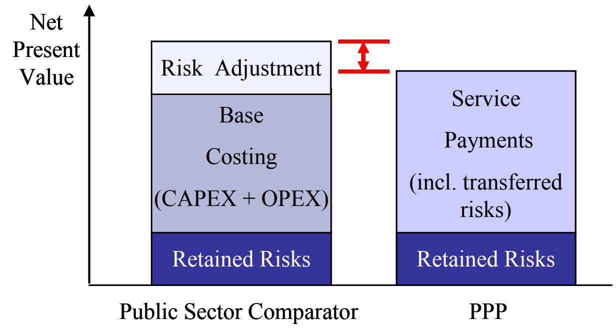


**Figure 2: Net Present Value of PSC vs. PPP**

Historically evidence suggests that public sector procurement tends to base budgets on low cost and early completion rather than the most likely outcome. This is arguably exacerbated, because public procurers have less incentive to manage risks effectively. Consequently, risk transfer comes out on top as the primary driver of VfM.

In essence, the VfM of a project is improved each time a risk is transferred to the private sector for which the private sector is in a better position to manage that risk on behalf of the public sector. This is particularly the case when the overall risk transfer package is coherent. Each risk which is transferred to the private sector, where the private sector is either unable or is not better positioned to manage that risk than the public sector, will reduce the VfM of the PPP project. Managing in most cases also implies having a certain level of control over the risk, even though many risks are not a 100% controlled by either party. For those risks where neither party is best to manage, evidence shows that new innovative solutions are found to deal with the risk as a consequence of a common interest to mitigate or control that risk for the success of the project.

### Financial Structure

The effective allocation of risk has a direct impact on the financial structure of the project, especially under a PPP deal where risk allocation is critical for the success of the project. The degree of risk transfer to the private sector will indeed influence the overall cost of the project to the public sector, as all risk will be associated with a price premium. PPPs are therefore often characterized by a more complicated financial engineering in the sourcing and combination of different financing types and allow for an efficient and innovative financial plan to realize large public projects.

In practice, sponsors will typically form a Special Purpose Company (SPC, see Figure 3) whose sole purpose is to own and operate the business and being clearly accountable for project delivery with a high level of management autonomy.

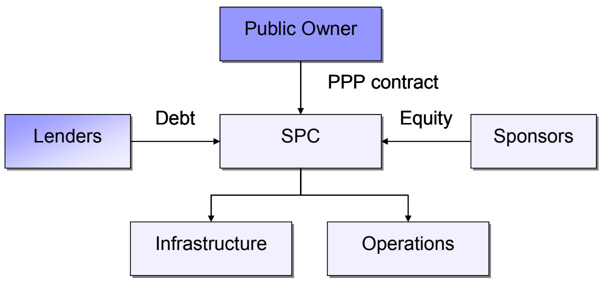


**Figure 3: Typical PPP Structure**

The debt/equity gearing does not simply depend on the costs of financing, but rather on the risks inherent to the project. Typically, since equity is rather more expensive than debt, PPP financial structures are highly leveraged, with gearing ratios ranging from 80:20 to 90:10. The gearing is driven by the risks, which themselves are driven by the complexity of the project, both technically and commercially.

### Service Payment Mechanism

The involvement of private funding in public projects is of primary interest to increase the effectiveness. In effect, PPP schemes allow the public sector to cope with lack of immediate funds by translating up-front capital into a flow of on-going service payments and potential grants, as depicted in Figure 4.

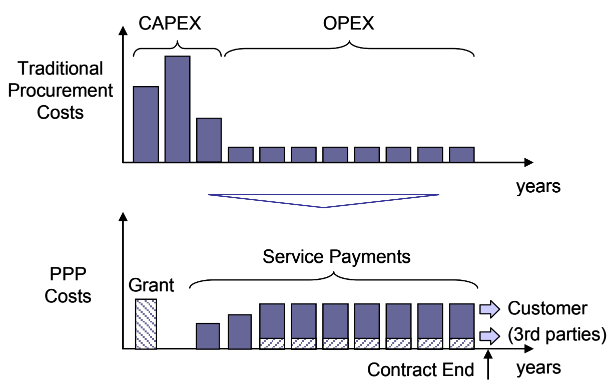


**Figure 4: Generic Service Payments**

The design of an appropriate payment mechanism is critical, as it gives financial effect to the risk allocation. Clearly, a tension exists between the public sector's wish to pay only for the services it consumes and the private sector's obligations to repay its debt to lenders, regardless of the level of use. As a result, there are two typical payment mechanisms designed for PPP projects:

- **Availability Payment**, where the contractor receives payments with respect to the availability of the service provided regardless of the level of use;
- **Volume Payment**, where the customer only pays for the utilization of the service provided by the contractor.

In practice, payment mechanisms are rather designed as a mix of these two concepts, so as to guarantee minimum payments to the contractor and to ensure vital incentives to perform. In addition, some PPPs allow – or oblige – the contractor to generate additional revenues from third parties or from the mass market. A revenue sharing mechanism may be then implemented.

Overall, PPPs can be considered to be more effective tools to finance and run projects for the public sector, primarily due to the appropriate allocation of risk. The potential for third party revenues also reduces the costs of the project for the original customer.

## PPP IMPLEMENTATION IN LARGE PROJECTS

### Introduction

#### *PPPs in the Transport Sector*

In Europe, the beginning of PPP can be traced back to the early 1990's, when PPPs were essentially applied in the UK under so-called PFI schemes. Since then, PPPs have been markedly widespread in other European countries, especially in the transport and construction sectors.

The study of sizeable programs in the transport sector, which have both strong technical and commercial approaches, provides interesting findings to compare with Galileo and Skynet 5. As a matter of example; the following PPPs have been analyzed:

- The Channel Tunnel Rail Link (UK, 1996) a 90-year DBFO concession to realize a high speed rail link between the Channel Tunnel and London [2];
- The IP5 Shadow Toll Road (Portugal, 2001), a 30-year DBFO concession to realize a highway link between Portuguese west coast and Spain [3];
- NATS Ltd. (UK, 2001), a public-private joint venture to develop the national air traffic services company [4];
- The High Speed Line Zuid (The Netherlands, 2001), a 30-year DBFM concession to realize a high speed rail link between Amsterdam and Antwerp [5];
- London Underground Ltd. (UK, 2003), three 30-year DBFM concessions to maintain and upgrade the London underground [6].

- Future Strategic Tanker Aircraft (UK, 2005 in progress), a 27-year UK MoD PFI contract to provide air refueling and air transport services to the Royal Air Force.

### *PPPs in the Space Sector*

PPPs have also reached some more strategic sectors such as defense and space, mostly following UK MoD initiatives. To date, two projects can be mentioned, the first one being the sole PPP/PFI ever contractually closed in the space sector:

- the Skynet 5 project (UK, 2003), and
- the Galileo concession (EU, currently in procurement).

In 1997, the British government conceived a military satellite communications system that would replace the MoD's current Skynet 4 satellites. The MoD chose the PPP route for the satellites because it believed that it would save the UK government £500m (c. €740m) over the life-time of the contract [7].

Under the 15-year DBFO concession contract, Paradigm Secure Communications Ltd (a 100% subsidiary of EADS SPACE Services) will deliver core military satellite communications to the UK armed forces, with the ability to commercialize spare capacity to third parties. This involves taking over the ownership and operation of the existing Skynet 4 infrastructure and incorporating two new Skynet 5 satellites and the associated ground segment refurbishments from 2005 onwards, with the full service available by 2008.

In 1998, the European Commission decided to investigate the development of a European Global Navigation Satellite System (GNSS), in coordination with the European Space Agency. In order to best meet the public sector's objectives whilst attracting private investment, a 20-year PPP scheme has been selected for the deployment and operation of Galileo.

A major specificity of the Galileo program is the staggered approach which has been used. The public sector (EC, ESA) will be responsible for the **Definition** and **Development & In-Orbit Validation** (IOV) phases. These cover the detailed definition and the deployment of a minimal terrestrial infrastructure, as well as the launch and testing of 4 satellites. Then, the **Deployment** and **Operation** phases will be managed under a PPP with a private Galileo concessionaire. The concessionaire will complete the 30-satellite constellation, the related ground segment and provide the users with the five Galileo services. The Operation phase will require the maintenance of the system and thus replenishment of the satellite constellation. Figure 5 displays the four program phases.

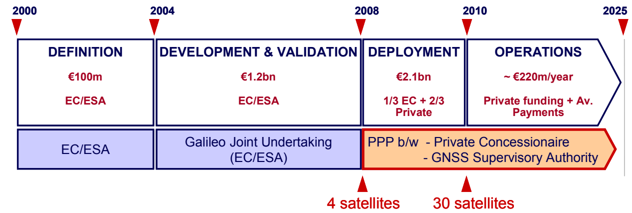


**Figure 5: Galileo Program Phases**

## Analysis of PPP Projects

### *Selection of the Procurement Model*

The procurement of a service under a PPP offers a wide range of possibilities to public entities that do not have the skills to run some particular projects or/and have budget constraints. In particular, a crucial skill is risk management. Analyzing PPPs in other sectors clearly shows that the complexity is a key differentiator since it reflects the risks inherent to the project:

- Technical, as a function of experience in similar projects, technology innovation, diversity of technology embarked, interdependency of project's phases and tasks, and external constraints;
- Business, as a function of competition, risk of substitution, service innovation, potential for regulatory support, market volatility and commercial viability.

Figure 6 displays several sectors where PPPs have been used with respect to both technical and business complexity.

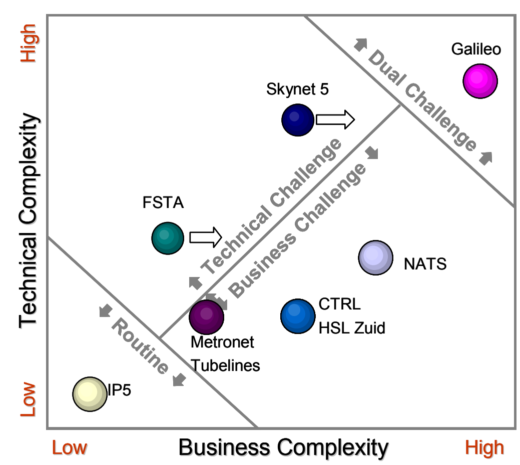


**Figure 6: PPP Projects' Complexity Mapping**

Since road and rail transport projects can rely on significant experience in designing and building such infrastructures, these projects are rather business driven, although the road market has a fair level of certainty. The air transport sector (NATS) seems more challenging commercially, .since this sector is far more sensitive to market events. Traditionally, the opposite would apply to governmental markets, especially in the case of military projects, where the technology is often the critical part of a project. However, the introduction of PPP schemes in these markets has triggered a more business-oriented approach therein, with Skynet5 and FSTA as an example.

By comparison, Galileo stands out as a global challenge with absolutely no experience to drawn upon. As a dual-use system serving both governmental and mass market applications, Galileo is on top the first PPP ever to be undertaken at EU level. In this case, the rationale for the selection of a PPP scheme was driven by the wish to optimize the procurement efficiency, to minimize public sector's exposure to risks and to reduce total life-cycle costs by benefiting from private sector's management skills. The involvement of private finance and the optimization of market revenue generation shall, as a matter of fact, help to reduce the need for public contribution over the 20-year concession period. The dual challenge of Galileo both technically and commercially raises the crucial issue of allocation of responsibilities.

***Allocation of Responsibilities***

The actual organization and allocation of tasks (Design, Build, Finance, Maintain, Operate etc.) in PPPs offers interesting findings. Usually, the complexity of the project, in addition to the actual partners' interests, drives the allocation of responsibilities. Firstly, because there may not be an ideal private partner that is able to bear the risks it was expected to bear. Secondly, since the public sector may have to keep operations under its control, e.g. for safety reasons, e.g. in the transport sector.

The transfer of responsibility for operations and the potential split between operations, maintenance and pure service provision appears relevant in some particular cases. In the Dutch HSL Zuid project, the PPP only covers construction and maintenance activities. Operations are performed separately under an exclusive license agreement with the public authority outside the scope of the PPP. This may be an efficient way to share risks and therefore to mitigate their impact on all stakeholders. However, this also suggests a significant amount of responsibilities retained by the public sector, with respect to its liabilities towards the operations company.

Here, Galileo differs from typical DBFO structures because of the staggered approach which has been used. Indeed, the public sector is responsible for the design of the system, as well as its development. The private concessionaire will only take charge after the so-called IOV readiness review, to complete the full deployment of the system. Figure 7 presents the proposed structure of the Galileo concession.

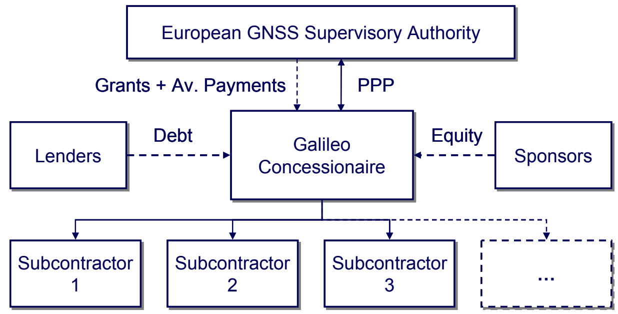


**Figure 7: Galileo PPP Structure**

The concessionaire's responsibilities are therefore composed of securing private finance, sub-contracting for the deployment and launch services, operating and maintaining the system as well as integrating European Geostationary Navigation Overlay System (EGNOS). This allocation of responsibilities, while avoiding conflicts of interests, has however significant impacts on risk allocation, which is discussed further on.

***Financial Set-Up***

The analysis of gearing ratios with respect to project's complexity reveals that high complexity projects have a lower gearing ratio, which is expected. Although complexity is rather a subjective parameter, PPPs are usually characterized by high gearing ratios for projects with limited complexity, and low gearing for very complex projects. Either because of the difficulty to secure high levels of debt for risky projects, or due to the potential cost increases right after the senior debt is secured and then covered by an increased amount of equity, as can be shown by two PPPs which were restructured (e.g. NATS and CTRL). Figure 8 displays the gearing ratio of some major PPPs versus the complexity of the projects [8]. In this diagram, (*) stands for original deal and (**) for restructured deal where appropriate.

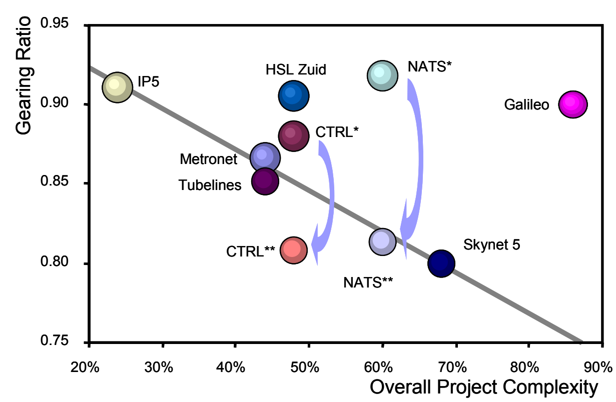


**Figure 8: Gearing Ratio vs. Complexity**

In the different cases studied, highly geared structures seem to be more vulnerable and some PPP deals were restructured after adverse events appeared. Clearly, there is a balance between the need to build a robust financial structure on the one hand, and private partners' wish to minimize equity investment in order to reduce their exposure. The separation of operational activities, as used in the Dutch HSL project, may allow a high gearing while building a robust project structure. This is essentially characterized by allocating the market risk to a third party, namely the train operator, under an exclusive license agreement outside the scope of the PPP.

Concerning Galileo, the target 90:10 gearing ratio appears relatively ambitious with respect to the overall project's complexity, by comparison to other PPPs. Experience shows that such a high gearing mark will only be achieved with a reasonable risk sharing. The degree of risk transfer to the private concessionaire shall not only be acceptable to the private sponsors, but also to the senior lenders. In addition, the set up of the financial structure of a PPP/PFI is driven by the market risk allocation of the project. In the case of Galileo, this is particularly important given the specificities of the satellite navigation market and will depend highly upon the public and private sectors to cooperate on revenue generating mechanisms to reduce commercial risks.

***Typical Risk Allocation***

The guiding principle for PPP risks allocation is that a risk shall be allocated to the party best able to manage it (or control it). Whereas the level of risk transfer to the private sector will vary depending on the project type, there is a typical risk allocation which is common to most PPPs. In practice, this shall be adjusted throughout the bidding process as well as iterated during the negotiation phase. According to some PPPs which have been implemented so far, a typical risk allocation for a PPP concession contract can be indicated, as proposed in the following [9]:

- **Design, Development & Construction Risks**: Private - The private sector is usually required to bear the risk of cost and time overruns. Contracting Authority however retains risk of changes to output specifications.
- **Operational & Maintenance Risks**: Private - The customer only provides output-based specifications, and the contractor is penalized when failing to meet service requirements.
- **Planning Risk**: Shared - It may be retained by the contracting authority for pilot projects. However, there may be occasions when transfer in whole or part is appropriate or unavoidable.
- **Performance Risks**: Private- This is where the availability payment mechanism is established to mitigate the performance risk.
- **Market Risk**: Shared - This risk is only shared or transferred when a reasonable certainty can be achieved in revenue forecasts with little or no dependency on public support (through regulations, etc…)
- **Policy & Legislative Risk**: Public - Public authorities are best placed to control regulatory and legislative risks, which can be critical in international projects such as Galileo.
- **Residual Value Risk:** Shared - This risk is strongly dependent on the duration of the contract and the nature of the assets.
- **Inflation & Other Financial Risks**: Private - This risk is often transferred to the contractor with possible use of indexation mechanisms.

However, the specificities of space programs do not allow such a typical risk allocation to be applied. This is due to the fact, that design, deployment (including launches), operations and maintenance of assets (especially space assets), market and residual value risks are more critical than in any other sector.

***Space Program Management***

As the space domain is objectively driven by institutional initiatives, programmatic issues present significant differences compared to other sectors. This suggests the need for a true partnership between the private concessionaire and the public customer, in this case the Galileo Joint Undertaking (GJU), composed of both EC and ESA staff. Nevertheless, Galileo also constitutes the first ever PPP undertaken at EU level, which further implies interaction with all EU and ESA Member States. Together with the political context inherent to space programs, the complex interfaces of a PPP add a new complexity layer which makes Galileo a unique program.

***Space System Design***

In the case of Galileo, the concession tendering process managed by the GJU has been conducted in parallel to the publicly funded design, development and validation phase under ESA management. After this so-called IOV phase, the public sector will transfer responsibility for the full deployment and operation phases to the concessionaire, who will interact with the GSA, the successor of the GJU.

This staggered approach has considerable effects on the implementation of the PPP, in particular for the negotiation phase since some risks associated with public specifications will be transferred onto the contractor for the operation phase. As a result, the risk allocation will significantly impact the establishment of an appropriate financial structure. A close cooperation between the private concessionaire and the public sector will therefore be a critical factor to the success of the Galileo PPP, more than for any other PPP. In the Skynet 5 case this was different, as the contractor took over an existing and operational system. The Skynet 5 satellites will of course apply new technologies and capabilities, but the project can heavily rely on past technical experience. Whereas in Galileo, EGNOS was conceived to give European industry a first experience in navigation systems based on satellites, crucial technologies necessary for Galileo are not part of the EGNOS program. The technology "jump" needs to be carefully analyzed and factored into the risk allocation profile.

***Space System Deployment***

The construction phase is generally an activity the private contractor masters quite well, especially in such sectors as transport and civil works where relevant experience exists. In the case of space projects though, it is necessary to distinguish between pure manufacturing and assembling activities and actual deployment of space assets, relying on launch services. Here, experience from former launches does not necessarily mitigate many of the related risks. To date, satellite services can present reliability figures greater than 98%. Still, a satellite launch remains a risky event in comparison with other sectors. Due to the criticality of a launch failure, for which the space asset(s) embarked can no longer be retrieved (total loss), the deployment of a space system is a critical phase. As a result, this has a significant impact on insurance costs and contingencies, likely to reach more than one fifth of the launch costs.

In addition to the insurance costs, the impact on deployment planning is also significant. In the case of Galileo, a 30-satellite constellation, the launchers will carry several spacecraft at the same time – from two to six, depending on the launcher to be used. This is can be very efficient in terms of cost and schedule, but also constitutes a single critical point failure in the project planning. Procuring several new satellites, with the associated long-lead items, can significantly delay the deployment phase – hence the need for a careful assessment and modeling of events and associated risks. Risk management and insurance concepts are key in a space program, especially when deploying several spacecraft for a constellation.

***Space System Operations and Maintenance***

As with regards to operational and maintenance activities for space projects, the amount of risk that can be transferred is difficult to quantify. A space system is usually a bespoke piece of equipment that will need to be used under conditions of extreme security. Important parts, such as satellites, are normally out of the reach of any maintenance activity. This emphasizes the need for redundancy in the spacecraft components as well as spare spacecraft to ensure performance in case of failures and outages. Again, this has a direct impact on insurance costs and contingencies and the risk the concessionaire is taking. Observation of GPS history shows, that the ability of the concessionaire to operate his constellation efficiently under contractual key performance indicators will be an area of major importance, which he will need to develop to commercially succeed. Here special care has to be taken with the constellation replenishment strategy, which requires substantial investment and again an adequate risk allocation in the case of mission evolutions to the Galileo system.

***Satellite Service Provision***

In essence, it is clear that the rationale for PPP schemes is to benefit from the private sector's skills, in particular in the commercialization of the services. However, demand risk is often something that the private sector cannot manage, because its crucial factors may be controlled by public decisions. Transferring the demand risk may therefore be bad VfM, as it involves pricing risks outside the control of the contractor. This is especially true, when the public side is a major customer himself.

A brilliant example to this is the case of PFI prison contracts in the UK. Demand risk was not transferred in these PPPs, after the private sector successfully argued that the use of prisons was not a risk that they could manage cost effectively, because they had no control over sentencing policy. This resulted in re-tendering the contract with a new payment formula based on availability (i.e. percentage of usable rooms) and service performance (e.g. cleaning services) rather than volume (i.e. occupation rate) [10].

Concerning Galileo, the uncertainty of the business model which has no precedent (civil GPS services are for free) makes the market risk a critical factor. Whereas market development will be a private matter, a regulatory framework will be essential to enable the penetration of GNSS services in specific areas were a value relative to a basic service can be turned into a benefit for users. A current example to this is given by recent regulation concerning the need to locate accurately any emergency call in the US (E-911) [11] or in the EU (E-112) [12]. Other examples are road tolling or law enforcement applications. Following the example of the PFI prison contracts, this part of the market risk influences both risk allocation and the service payment mechanism.

***PPP Service Payment Mechanism***

The service payment mechanism is therefore critical to the success of a PPP since it links risk and responsibility transfer to the financial structure.

There are several ways of mitigating market risk, depending on the sector. As far as road transport is concerned, so-called shadow toll regimes under which the contractor is paid by the public sector in relation with the number of users is a widespread scheme. Users actually don't pay directly through real tolls; the costs are financed by taxpayers. Such schemes though have sometimes been considered "unfair" to end-users, as they do not link volume of use per end-user with the cost he incurs, i.e. the tax payment. Recent discussions on the UK road user charging scheme highlight difficulties of such schemes [13] and the need for fair charging concepts, i.e. distance based schemes. Nevertheless shadow toll regimes are very simple to implement by the public side and can therefore be considered as very effective scheme.

The Skynet 5 deal presents an innovative arrangement as a mix of both availability payments and volume payments, with ability to attract third party revenues. On the one hand, payments directly reflect the use of the services by the original customer (the UK MoD) with a minimum payment level that guarantees revenues. On the other hand, the contractor is given the right to sell the spare communication capacity, not used by the UK MoD, to third parties, hence allowing for additional revenues. This may turn into a very attractive business if the commercialization of third party revenues is successful and can above certain levels reduce the costs of the project for the original customer, the UK MoD.

During the early years of the Galileo concession, the contractor will receive availability payments from the public sector so as to match with the revenues required to cover the entire costs of the project if the forecasted revenues materialize. At a defined point in time the market revenues should be sufficient to cover the costs and hence the availability payments are reduced to zero. However, the commercial aspect of Galileo has to be driven by a mechanism which allows for incentives for both the public and private sectors. Such schemes are addressed in general under revenue sharing mechanisms, but may also take other innovative forms.

## RECOMMENDATIONS

The above analysis has highlighted some characteristics of representative large PPP projects in the transport and construction sectors and allowed a comparison with the space sector. This leads to a considerable number of differences inherent to the specificities of the space programs. The following figure maps some of these specificities against several criteria, relevant to the nature of the projects or the actual structure of the deal.

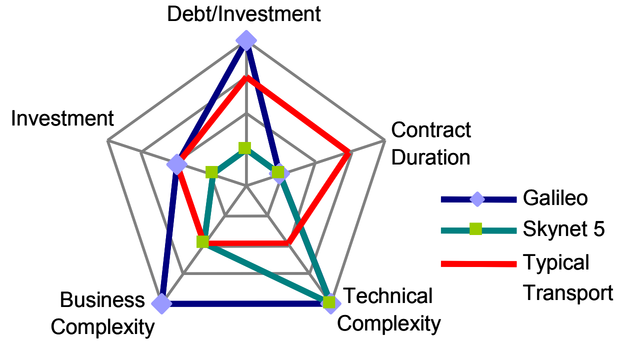


**Figure 9: Comparison of Representative PPPs in Transport & Space Sectors**

Clearly, both technical and business aspects are key differentiators to the projects analyzed in the present paper. In particular, it goes without saying that Galileo is a very challenging project technically and commercially. It shows that, whereas the space sector has some very specific challenges compared to other sectors, the PPP schemes can be successfully adapted to answer the needs from public customers. This can only be achieved if some few common principles are respected in the frame of a true Public-Private Partnership. Figure 9 highlights the differences discovered in comparison with PPPs in other sectors. Technical complexity is considered high in space sector PPPs and relates to a lower debt/investment ratio, which reflects the gearing ratio. The technical complexity is not only driven by technology but also by the specifics in the construction phase, for example launch events. This is particularly true for space constellations. Overall investment volume for Skynet 5 has been under the average PPP, but Galileo reaches the typical levels found in other sectors. Contract duration is also shorter than in most PPPs in other sectors, probably reflecting the system design lifetime, but this does not necessarily need to be the case as Galileo proves. Business complexity clearly is a differentiator in Galileo making it a dual challenge, i.e. both technically and commercially. Without doubt these specific differences have had or will require adapted PPP/PFI schemes and appropriate risk allocation profiles.

### Relevant Allocation of Responsibilities

It is of primary importance to respect the actual interests of all stakeholders and not to seek a complete transfer of responsibilities to the same party. In particular, it may be relevant to limit the scope of the PPP to certain engineering activities, and treat more business oriented, such as operations and service provision, outside the scope of the PPP as examples in the transport sector show (HSL Zuid).

As for the private sector to take responsibility of the program implementation, it is of major importance that the contractor has a "pilot in the seat" and preserves continuity of the program management through the tender, negotiation and implementation phases despite their usually long duration (typically 3-6 years). PPP projects, especially in the space sector, require a range of competences not necessarily needed in traditional procurement approaches. Exemplary are:

- Unique risk modeling, liability management and insurance expertise;
- Business modeling capabilities and structured finance competences;
- Legal and regulatory know-how (frequencies, licenses);
- Procurement and subcontracting management skills for technically bespoke complex systems.

The use of advisors may substitute for competences which are not existing internally, nevertheless experience shows that a "pilot in the seat" covering all key aspects is the best solution and it is in the interest of the sponsors to sufficiently master and control above mentioned aspects.

### Optimization of Risk Transfer

The overall principle of allocating a risk to the party best able to manage it shall be respected, as it constitutes a critical success factor to the implementation of PPPs. It is a fundamental principle governing all PPPs regardless of the sector. As far as the space sector is concerned, the present analysis has highlighted the specificities of such projects and the inherent competencies required throughout the various phases of the projects. Even though the "standard" allocation may not change, new skills may be required in the private sector to manage the risk. For Galileo therefore, market risk allocation will certainly be an area of detailed discussion between the public and private sectors, as well as the technical design risk.

### Joint Commitment to Develop the Program

Commitment is especially important when the public sector has a strong influence on the development of markets, for instance through regulatory initiatives. The nature of the satellite navigation market makes Galileo a real business challenge, and requires the interaction with public institutions with respect to the regulatory environment, certification and standardization issues, as well as international cooperation and other issues which may have an impact on the revenue generating capability of the concessionaire.

### Development of a Relevant Framework

The successful implementation of PPPs also requires a suitable framework to be developed. As an example, the current European space ambition faces budget constraints which can be resolved, or at least minimized, by two solutions. The first one is by using innovative financing schemes (PPP) in order to avoid significant up-front budget requirements. The second one requires the harmonization of national requirements across the EU, so as to coordinate and implement common projects. If using PPPs is increasingly being considered across Europe, EU Member States definitely need to coordinate their actions to actually get the benefits from what PPPs can provide for internationals projects. The same applies of course outside of Europe. Suitable legal and procedural frameworks can determine the success of a PPP.

## CONCLUSION

The spread of Public-Private Partnerships beyond the traditional sectors transport and construction into more strategic sectors such as the space sector has opened a new way of thinking. In particular, the implementation of PPP schemes within the space sector, initiated by the EADS SPACE Services led Skynet 5 project, and furthermore with the on-going Galileo program, paves the way for further future projects. Beyond the possibilities offered by PPPs, those schemes have above all brought innovative tools to help the public customers realize projects of public interest. PPP projects are a way to provide a win-win situation for both the public and the private sectors, if the specific differences which exist in Space programs are taken into account. The specific differences are driven by the business and/or technical complexity of the programs as shown. This has an impact on the financial structure of the project and the allocation of responsibilities and risks.

Nevertheless, not all countries have the necessary legal and procedural frameworks to realize PPP projects. Even though the number of projects which can be developed and implemented by the public and private sectors is finite, the current number of space PPPs is limited in comparison with other areas. The EC has already started working on this issue with the private community in publishing a Green Paper on PPPs [14]. The results will hopefully set up the basis to harmonize a concept at European level and help the appropriate environment to be further developed. This will at least provide a basis on which new space projects of public interest may be launched despite budget constraints.

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