Toulouse Space Show 2012 : IISL/IAA Space Law and Policy Symposium
Session 1a : Towards effective sustainability for outer space activities

ECONOMICAL SUSTAINABILITY OF THE SPACE VALUE CHAIN : ROLE OF GOVERNMENT, INDUSTRY, AND PRIVATE INVESTORS

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ABSTRACT

There is no single answer to the question of assuring the economical sustainability of a space business segment along the full value chain. The main question is generally to guarantee that part of the money earned at the level of the downstream services to users can circulate backward, to fund the upstream space infrastructures.

Government agencies, space industry and private investor communities have a role to play, but in many different ways. Depending on the size of the infrastructure investment, the volume of the downstream application business, the maturity of the market, the nature of the customers (public sector, private corporate, mass consumers, …), there are a lot of possibilities of interaction between the governments, the industry and the private investors.

The paper will present the key characteristics of these various actors and their drivers and constraints. This will be applied to show how they play together in the frame various business models, illustrated by concrete examples.

FULL TEXT

1. Sustainability of the Space Value Chain

Between the manufacturing of satellites and the final use of the derived applications by the consumers, the space value chain can be described with the following key levels and actors (see Figure 1) :

- *Manufacturing* : space industry develops and manufactures space systems and associated ground segment and user terminals
- *Launch services* : launch operators deliver the satellites into orbit
- *Lease or sale of satellite capacity or data* : the satellite operators own and operate their satellites, and sell direct services such as communications bandwidth, positioning signal, or Earth observation data
- *Value Added Services* : the service providers buy satellite capacity or data, control ground stations and networks, and deliver high value services, such as global communication solutions, track and trace, geo-information services, …

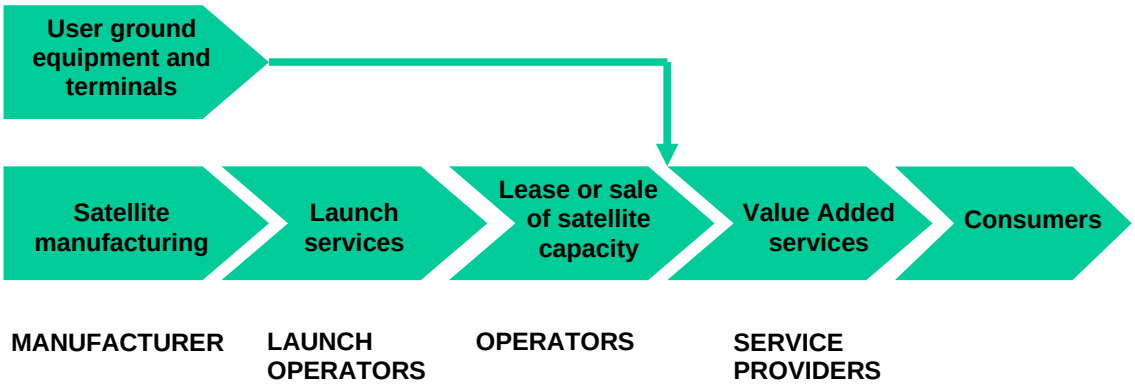

Figure 1 : The space value chain

Between each level, a business can be created, with seller/customer relations, and the possibility of investment and earnings for the private sector.

The largest part of the private commercial business lies on the downstream part of the value chain, where services are delivered to end users, being they institutions and corporates (e.g. military communications, land mapping, environment monitoring, ATM, M2M communications, …), or mass market (e.g. direct TV, mobile communications, Google Earth, GPS receivers, car navigators, …). That's also where the highest profits are earned.

However, all these services are relying on space infrastructures (telecommunications and Earth observation satellites, navigation constellations) and their sustainability along large periods of time. As a consequence the robustness of the global value chain shall be guaranteed by mechanisms enabling the cash transfer from the downstream earnings back to the infrastructure investment.

But very different actors play in this business, thus making these mechanisms complex and fragile : government through space agencies, manufacturing industry, service operators, private investors, … All these actors have different characteristics, different objectives, and different constraints. Their roles and relationship are rather different depending on the point of the value chain where they have an action.

2. Typology of space value chain actors

Manufacturing companies :

Investments for space systems range from several billion and long development cycles (7-15 years) for large infrastructures and medium to heavy launchers, to hundreds million for telecommunications, Earth observation or science satellites and small launchers, and tens million for mini satellites, subsystems and equipment.

This has been mainly the domain of the "classical" space industry, with large and small primes, subsystem contractors, and equipment suppliers. This industry has generally close synergies with the defence sector.

The size of the companies is ranging from several billion revenues for the global primes (Boeing, Lockheed Martin, Northrop Gruman, Astrium, Thales Alenia Space) to hundreds million for the satellite primes (e.g. Loral Space Systems, OSC, OHB), and tens million for equipment suppliers.

But recent trend has seen the emergence of new small private primes, with classical shareholding structure in Europe (e.g. SSTL), or backed by business angels in the US (Space X, Scaled Composites, Bigelow, …).

Launch operators :

As a consequence of the very specific nature of the launch sector, which is generally considered a sovereignty domain for the space faring nations, the number of launch services companies is rather limited (less than 10) and they are generally "daughter companies" of the launchers manufacturing companies (Arianespace shareholders are the European launcher industry and CNES, ILS is owned by Khrunichev, ULA is a joint venture of Boeing and Lockheed Martin, …).

Again a new paradigm has recently emerged in the US with SpaceX, created by an Internet tycoon, but now fully integrated in the NASA and DoD government business.

Space operators :

The typology of the space operators is different depending on the application : telecommunications, Earth observation, or navigation. The generic characteristic of these actors is to operate space assets and sell bandwidth capacity or data.

For *telecommunications*, the commercial business is rather mature. The sector is highly concentrated with about 30 actors, the Top 4 concentrating ~60 % of the revenues (SES, Intelsat, Inmarsat, Eutelsat). Most of these actors have been acquired by private equity funds during the past 10 years (shareholding of some of them has changed several times).

For *Earth observation*, the business is not as mature, since observation satellites have been owned and operated by governments for a long time. There are 3 main private actors, GeoEye, Digital Globe, and Spot Image.

For *navigation*, the business of private space operators has not yet materialized, since the only existing positioning systems GPS, Glonass and Beidou are owned and operated by government agencies mainly for military purpose, and the access to the civil signal is free. It will be one of the challenges of a future Galileo operator to create a commercial service.

Value Added Services providers :

This downstream part of the value chain is generating the highest revenues, and is addressing directly the end users. It is more a world of information technology. There are a lot of companies, from established service providers (mainly in telecommunications), to small start-ups addressing niche market segments. The market structure is very scattered, in particular in the geo-information services sector.

The investors of the space value chain :

Several kinds of investors might intervene at different levels of the space value chain :

- Government, e.g. for the development of large public infrastructures
- Private industry, e.g. for the development of commercial telecommunications generic platforms, small launchers, or personal spaceflight systems
- Banks, through loans to operators or industry
- Equity funds, e.g. for the acquisition and consolidation of the telecommunications operators
- Venture capital funds and business angels, e.g. for technology start ups, and “new space” companies

All have different financial capabilities ($ billions for banks, $ millions for VC funds), different time objectives for return of their investment, different approaches of the risk taking, and different exit strategies.

The particular case of governments :

Governments have been the first and only users of space systems for a long time, and are still major “space consumers” today, for security and defence, public services (e.g. meteorology), basic research, science, exploration, and human space flight. They are therefore key actors of the value chain, playing different roles from investor for infrastructures to end user of applications and services :

- Consumers of space applications or services, procured on a pure commercial basis (e.g. DoD with Intelsat for telecommunications)
- (co) investor, (co) owner, user of space infrastructure, the operations being held by a private operator
- Investor, owner, operator and user (e.g. science satellites)
- Consumer through long term concession to a private operator

3. Who should play where ?

Generally the space operators shall pay for the infrastructures, or get it from governments. The value added service providers have limited investment in infrastructure, generally ground terminals and networks. The main problems associated to these investments are their amount (from hundreds million to billions), the payback time and level of ROI, and the risks (technical and business) to be shared between the manufacturing industry, the operators, the investors, and the value added service providers.

If the application sector is only emerging and not mature enough as a commercial business, and the investment is larger than tens millions, the risk is generally not acceptable for the private investors. A public support is needed for for R&T and experimentation/test, and for initial infrastructure investment to start the application business. This has been the case for the telecommunications applications in the 60s-70s. The government can also create the regulation supporting the commercial development, and sponsor the initial service providers (e.g. through tax relief).

When the maturity of the domain allows a good forecast of the market and of the competition, then the business uncertainties and risks are highly decreased. If, in addition, the infrastructure investment is proved to be covered by the service earnings, the value chain can become purely private, as it is the case for telecommunications. The private investors are banks or equity funds, which can withstand investment levels of several hundreds million. In some particular cases, business angels could invest such volumes, but initially more for personal interest than for guaranteed ROI (e.g. SpaceX).

The playing field for venture capital funds and business angels is more at the level of the equipment industry, when promising technology start-ups are identified, and at the level of the value added services providers, where the investment are limited, and the profit potential is good.

4. Typical examples of business models

Typical examples of actual business models for space applications are described hereafter, to illustrate the variety of possibilities. The fluxes of money, delivery of systems, and of services between the different actors, are shown. They are representing the variety of solutions already existing in the space business to guarantee the sustainability of this business.

Classical institutional business model

This model is addressing programs of strategic or political importance, or not leading to commercial applications (e.g. space science, military, human spaceflight, …). Government agencies are procuring space systems from the manufacturing industry, and operating these systems to deliver services to government or to citizens (Fig 2).

This model will continue in the future, in particular for one-shot applications (e.g. an astronomy satellite), or for missions which need to be fully controlled by governments for strategic reasons.

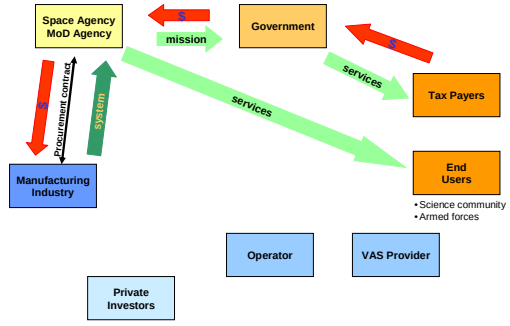

Figure 2 : Classical institutional business

Government owned, company operated (GOCO)

A derivative of the previous scheme, the GOCO model, is sometimes applied when the government does not want to keep the duty of operating the system, or when the system owned by the government might have commercial applications beside its public service purpose. In that case the operations of the system and sale of the services are granted to an operator, through a concession, a convention of use, or a licensing scheme (Fig 3).

Examples in Europe have been the operations of the Ariane family by Arianespace, and the exploitation of the SPOT satellites by Spot Image.

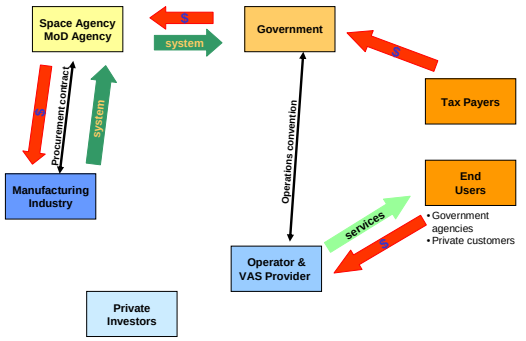

Figure 3 : GOCO model

The concession model : Paradigm

Going further towards the disengagement of the government from the infrastructure duty, the concession model applies to a global solution and service delivery to the public customer. It is a particular case of a PPP (Public Private Partnership), the PFI scheme (Private Funded Initiative). The private operator invests with private funds for the development of the infrastructure, and gets back his investment and earns benefits, through the sales of services to the public partner, in the frame of a long term concession contract.

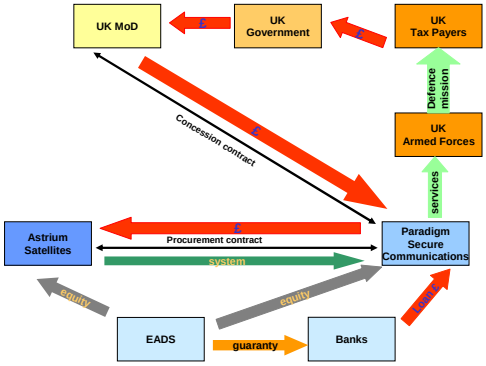

Figure 4 : The concession model

A successful example is the Paradigm project in the UK. The UK MoD is procuring secure communications services from Paradigm Secure Communications (PSC), which has got a long-term concession contract. PSC has invested for the development, manufacturing, and launch of the Skynet 5 system (4 satellites). Astrium Satellites is the prime contractor for the development of the system. The funding for the Paradigm investment is coming from banks through loans, the risks being backed by EADS, as mother company of Paradigm Secure Communications (Fig 5).

The co-ownership model : TerraSAR-X

Another PPP example is the case where the public and the private partners are deciding to jointly invest and own a space system, in order to share the funding and the risks. This is applicable when the application services are addressing both the public needs and the commercial market, and when the level of investment for the private partner is compatible with the size and robustness of the commercial market. The rights of use of the system for both fields of application have to be agreed between the partners, in particular for the sharing of the operational capacities. In some cases, a mechanism of payback to the public partner can be implemented, through fees from the commercial earnings.

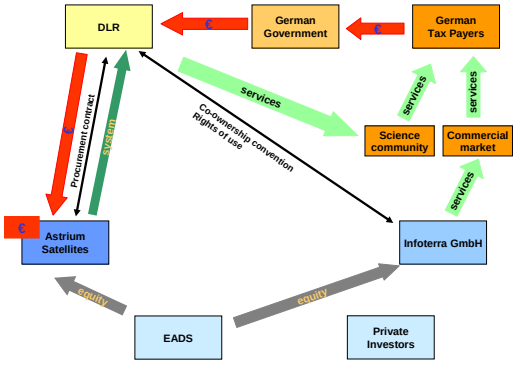

Figure 5 : The co-ownership model

The Earth radar observation Terra SAR-X is an on-going example for such a scheme. The first satellite has been jointly funded by the German DLR space agency and Astrium, and launched in June 2007. The rights of use are equally shared between the DLR for the scientific use, and Astrium Geo-information Services for the commercial market (Fig 5).

A mature private business : Commercial Telecoms

After having been supported by the governments in the 60s-70s, the commercial satellite business for telecommunications is now mature, and is no longer relying on public funding. Established operators, generally owned by equity funds, have the financial capacity to invest for the replacement and upgrade of their satellite fleets, thanks to a solid market for the sale of bandwidth capacity, their customers being generally value added service providers, agreeing to sign long term contracts. These value added service provider are themselves addressing a fruitful mass market for direct TV, radio or Internet services, or corporate market for more specific services (Fig 6).

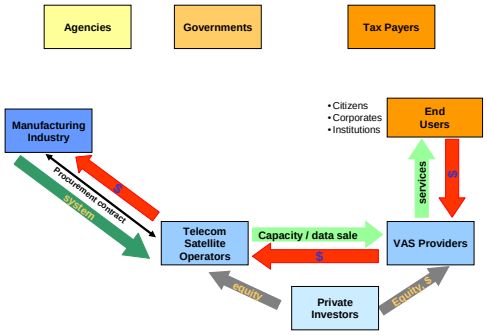

Figure 6 : Mature private business

GPS applications, a pure Value Added Services model

Today the navigation value chain is proposing a very specific model, since there is no economical linkage between the infrastructure investment and the commercial services. The GPS system is funded by the US government, but for military purpose. The civil signal being offered free of charge worldwide, there is no demand today to reimburse this investment, and the level of a commercial space operator does not exist.

Therefore the commercial value chain starts in fact at the level of the value added service providers, which address a large variety of customers, and can develop new applications and propose new offers, with very limited investment.

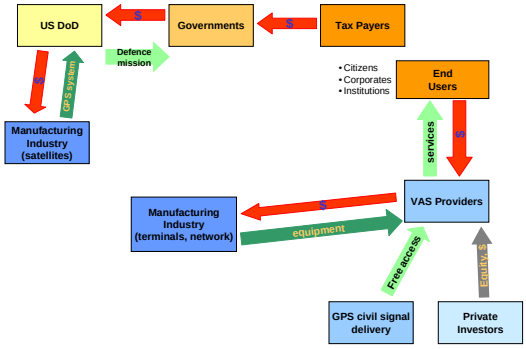

Figure 7 : VAS model

Private investors such as venture capital funds can be very active in this field, which has some similarities with the IT world (Fig 7).

5. Conclusion

The examples of Galileo and GMES in Europe are demonstrating the difficulty to guarantee the long term sustainability of key space infrastructures and associated services, when the initial intent is to escape from the traditional government procurement business model.
The various examples discussed in this paper show that there is a broad spectrum of business models which could apply to each specific case, mixing private and public funding.

Therefore there are a high potential and a lot of opportunities for all the actors of the space value chain to be creative in fostering the most appropriate business models to develop the space applications, for public or commercial market, and often a mix of both.

The main issue/discussion for these actors is the sharing of risks, being they technical or business. Guarantees and backing mechanisms shall be found to convince the private investors to accept these risks.