Impact Assessment Relating to the Economic and Governance Evolution of Space in Europe

Final Report

prepared for
DG Enterprise & Industry

RPA

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Impact Assessment Relating to the Economic and Governance Evolution of Space in Europe

prepared for

European Commission, Directorate General Enterprise & Industry

by

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EXECUTIVE SUMMARY

Background to Study

The European Commission and the Council of the European Union are committed to a growing European Community involvement in space-related research and development. This includes research and development into satellite technologies and applications, the introduction of operational satellite systems and the development of clear policies on space-related issues (including at the international level).

The Commission is also working in increasingly close cooperation with the European Space Agency (ESA) and these two bodies (the Commission and ESA) are currently drafting a European Space Policy (ESP) and an associated European Space Programme, in consultation with Member States of the EU.

Study Objectives and Associated Tasks

In developing the ESP, the Commission must prepare an assessment of the impacts associated with the different policy options under consideration. This study was commissioned to assist the Commission in preparing a rigorous analysis of the different options. As indicated in the Task Specifications, the objectives of this study were:

- *to assemble information on the principal markets for space and space-related hardware and services and a range of realistic scenarios for market development;*
- *to establish the ability of the European industry to achieve a significant share of profitable sales in those markets which are accessible and identify factors within the European Space Policy which may affect that position; and*
- *to consider the roles which key public sector actors in Europe have in influencing the competitiveness of the industry and assess the impact of different options for organising public sector activities.*

Furthermore, to meet these objectives, the Commission set out nine specific tasks (A to I) to be undertaken in three phases:

➢ ***Phase 1:***	*Task A: Project Scoping*
	Task B: Analysis and Summary of the Space Market
	Task C: Compilation of Demand Scenarios
	Task D: Selection of Demand Scenarios
➢ ***Phase 2:***	*Task E: Scenario Analysis*
	Task F: Analysis of Alternative Management Models
	Task G: Analysis of Impacts of Regulation
	Task H: Interim Reporting, Discussion and Commenting
➢ ***Phase 3:***	*Task I: Final Reporting*

This Final Report, which builds upon the Interim Draft Report (Tasks H) and Draft Final Report (Task I), includes:

- *an analysis and summary of the present space market at global and European levels (Task B) including a detailed analysis of different sectors and key players;*
- *an analysis of the current space-related regulations, international agreements and other factors (such as standards) which may impact the activities and profitability of the European space industry (Task G);*
- *the development of four future demand scenarios and an assessment of the implications for the sustainability of the European space industry (Tasks C, D and E); and*
- *an analysis of the roles of the key public sector actors and an analysis of potential future management models (Task F).*

A brief summary of the key findings for each of the above areas is presented below.

Current Space Market

European countries, led by France, Germany, UK, Italy, Belgium and Spain, are involved in space activities. The EU is also becoming a significant actor and contributor of funds. The annual European institutional civil budget is steadily increasing and is now over €5 bn, most of which is directed through the European Space Agency (ESA). The annual European institutional military budget is much lower at less than €1 bn[1]. Although Europe is the second largest global player in space, its annual institutional budgets are dwarfed by those of around €13 bn and €15 bn for the US civil and military budgets respectively.

Detailed analysis suggests that the annual turnover of the European space manufacturing industry from European institutional budgets is about €2.7 bn (i.e. nearly 50% of the total budget) - although uncertainties remain in the differences between the institutional budgets and the industry's turnover.

The commercial space market is usually characterised as having three segments - telecommunications, Earth observation and navigation. Although the European downstream market (comprising commercial value-added services) is large, the value of the 'space' element (development, construction, launch and maintenance of satellites) is less than €2bn per annum to the European manufacturing industry. Although much more cyclic in nature than the institutional budgets, recent years have seen an increase in commercial markets.

Most areas of space activity involve limited numbers of key players. Europe has three of the 20 global satellite manufacturers and one of the four global commercial launcher companies. Similarly, in the important fixed satellite services (FSS) market, two European companies account for 30% of the global turnover.

[1] European military space budgets declined in the late 1990s before increasing again.

Regulatory and Other Issues

Overview

The European space industry operates within a complex framework of requirements including regulations and international agreements. Since the space industry is characterised by infrequent and expensive projects, the loss of a space related contract due to undue requirements could have serious implications for the companies involved. These requirements were assessed and consultation was held with a range of stakeholders to assist in identifying the key areas where measures could be taken at an EU level to improve the situation (with particular regard to market access). The two key issues (as discussed further below) are:

- *controls over the exchange of items (or ideas) which may have both civil and military (dual-use) implications; and*
- *reaching international agreements on operational 'slots'.*

A further issue which is emerging in importance is that of liability relating to space debris. This was an area where stakeholders felt that future regulation at a European level (and associated negotiations at a global level) could provide greater clarity and harmonisation.

Dual-use Export Controls

There are two control regimes of interest - EU exports and ITAR. Although the EU export of items with the potential for military use is subject to EC Regulation 1334/2000, there is a widespread view that the regulatory regime needs to be improved. To address such concerns, the Commission published (in December 2006) a "Communication on the Review of the EC Regime of Controls of Exports of Dual-use Items and Technology". The purpose of this Communication is to improve clarity, coordination and security over the potential export of dual-use items from the EU.

The corresponding US system is ITAR (International Trade in Armaments Regulations) which is applied rigorously by the US to restrict the export of sensitive technology (and ideas) from the US. Whilst ITAR can create difficulties for European industry in, for example, obtaining critical components from the US, it can also provide opportunities. In particular, European companies can offer ITAR-free systems (for some applications) for export, thus gaining market share over the US. As such, on balance, ITAR is not seen as major problem for the European industry.

Allocation of Slots

Satellite communications rely on the use of selected frequencies of the radio frequency (rf) segment of the electro-magnetic spectrum as well as selected geographical positions of satellites. These frequency/position 'slots' are allocated by the International Telecommunications Union (ITU). Although the procedures appear to work well, some stakeholders suggested that there is increasing competition for particular slots, especially from terrestrial operations. As such, operators would welcome an additional European 'voice' in support of applications for slots for European space activities.

Demand Scenarios

Introduction

There is sufficient information available to provide robust estimates for the numbers of satellites launched in recent years (and, to a lesser extent, associated market value) and for those to be launched in the next few years. Thereafter, the future becomes less certain and three demand scenarios were considered in addition to the Business as Usual (BAU) scenario. The scenarios were initially based on those developed by OECD in its predictions for the space industry to 2030, but have been refined following detailed examination and review during the course of this study as summarised below:

- ***Scenario 1** is a relatively optimistic scenario, with a generally peaceful world, the growth of global trade and the internationalisation of production worldwide. Cooperation among nations contributes to the solution of world problems. However, organised crime and terrorism continues to be active, and the environment continues to deteriorate (although less than in other scenarios);*

- ***Scenario 2** has three major economic powers dominating the world: the US, Europe and China. The economic powers of the US and Europe are gradually weakened and they choose to strengthen ties with each other and to coordinate military forces (including a European military space programme). This gradually leads to a bi-polar world, where rivalry between Western and Eastern blocs dominates the policy agenda; and*

- ***Scenario 3** is a relatively pessimistic scenario. Strong disagreements among major powers lead to a gradual erosion of international institutions and international trade. Economic conditions deteriorate as the world reverts to protectionism and growing social and ecological problems are largely ignored.*

Demand Scenario Summary

The demand scenarios are summarised below:

Demand Scenarios for Europe (2012-2021)

	BAU Scenario	Scenario 1	Scenario 2	Scenario 3
Commercial Market				
Growth	+4% pa	+7% pa	+3%	-10% pa
Satellites/year	5 per year	6 per year	5 per year	2 per year
Institutional Civil Market				
Growth	+2% pa	+10% pa	+2% pa	No growth
Satellites/year	7 per year	11 per year	8 per year	5 per year
Institutional Defence Market				
Growth	-2% pa	No growth	+10% pa	+5% pa
Satellites/year	1 per year	2 per year	6 per year	5 per year
Total satellites	**13 per year**	**19 per year**	**19 per year**	**12 per year**

Implications for European Space Industry

Although there are clearly different growth patterns amongst the various demand scenarios, the conclusion is that the steady growth (in overall terms) seen in recent years is likely to continue into the foreseeable future. The implications for the European space industry are outlined below for each scenario.

Under the Business as Usual Scenario, the commercial and institutional civil markets continue to expand. However, the institutional defence market declines due to greater use of commercial applications for military uses and greater coordination amongst European states.

Under Scenario 1, the commercial market is strong and private investment in space increases. Commercial interests increase in navigation and Earth observation and therefore the private sector takes on greater responsibility for these applications. Export potential is high as there are no barriers to global trade, but there is stronger competition from emerging space-faring nations. Therefore, efforts to improve technical capability, competitiveness and efficiency are of most importance under this scenario in order to sustain the European space industry.

Under Scenario 2, European institutions take on responsibility for security and defence applications, whilst Members States maintain some roles in civil applications such as space science, Earth observation and telecommunications. High levels of uncertainty about the macroeconomic climate and about the demand for satellite-based services will have a detrimental effect on the private sector's propensity to invest in satellite infrastructure. Due to the political environment (and further development of emerging industries), access to the global markets is limited, therefore additional efforts are needed to maximise access to the extent possible, requiring a more competitive and efficient industry.

Under Scenario 3, economic conditions deteriorate as the world reverts to protectionism. Restrictions on imports of components from the USA and Japan could have a significant detrimental impact on the European space industry's ability to manufacture cost-effective satellite systems. Member States take a greater role in both civil and military applications. Limited export markets remain open, and these must be exploited to the extent possible, while civil budgets are largely devoted to the development of dual-use technology. There is more investment (in comparison to BAU) from the military sector in response to the more difficult security situation and this contributes to maintaining and developing the technical knowledge base in Europe.

Evolution of the ESA/EC Framework

Background

ESA is an inter-governmental organisation which has led the European space effort for the past 30 years. There are 17 ESA Member States comprising the EU-15, Norway and Switzerland with formal cooperation agreements with a number of other countries. Many projects funded by Europe's national civil space budgets are managed by ESA. In some *cases, partial funding is provided by the European Community (EC). ESA and EC have also established joint structures to manage large projects such as Galileo. In addition, ESA co-operates with the EC under a formal ESA/EC Framework Agreement.*

The future evolution of ESA/EC co-operation will form a key part of the European Space Policy and the associated European Space Programme, currently being prepared by the European Commission and ESA.

Options for Evolution

There is a perception that the current arrangements for managing the development and exploitation of European space activities need to evolve, inter alia, to be more inclusive of all EU Member States, to ensure that Europe maintains its position on the world stage and to stimulate and sustain a competitive European space industry. Such an evolution is likely to lead to greater involvement of the EU.

*Four options in addition to **Option 1 - No Policy Change** were considered in the analysis:*

- ***Option 2 - Revised ESA/EC Framework**. Option 2 has been taken to represent a possible evolution of the existing framework. As such, most institutional civil space activities will continue to be run by ESA, headquartered in Paris, with cooperation from the EC. However, some steps are taken to increase European participation and efficiency. It is also proposed that consideration be given to aligning ESA policies for work allocation more closely to the principles of EU competition policy.*

- ***Option 3 - European Community Agency**. In the longer term, it would be possible to establish a Community Agency under the EU's first pillar. Although the role of non-EU ESA Member States (Switzerland and Norway) would be diminished, they would still be able to participate in the activities of a Community Agency. The overall direction of the Community Agency would be the joint responsibility of Member States and the Commission (as represented on the Administrative Board). The focus of the activities of a Community Agency would be on civil projects and, as such, should not lead to substantial changes in the nature of the work undertaken. However, it would be expected that one area of potential change would be that projects would be awarded to contractors on the basis of rules and procedures more closely aligned to those of the EU.*

- ***Option 4 - European Union Agency**. In the longer term, it would be possible to establish an EU Agency under the EU's second pillar. As for Option 3, this would be a complex and lengthy procedure and the role of non-EU ESA Member States (Switzerland and Norway) would be diminished although co-operation with non-EU countries would continue to be encouraged. The overall direction of the EU Agency would be the responsibility of Member States. The focus of the activities of an EU Agency would span all space activities including projects with (potential) dual use applications. This would lead to changes in the emphasis of the work undertaken but would not necessarily requires changes in the staff undertaking technical and administrative duties. It would be expected that work allocation rules would be determined by Member States (through the Administrative Board).*

- ***Option 5 - Executive Agency***. *The establishment of an Executive Agency represents the greatest change from Option 1 and would (effectively) move the responsibility for European space activities to the Commission. The Executive Agency would be responsible for implementing the 'space' programme. However, one area of significant change would be that projects would be awarded to contractors on the basis of EU rules and procedures. There would also be a need to establish a focal point within the Commission (in Brussels) to first develop the programme for implementation by the Executive Agency. This Space Bureau would also be responsible for 'space' policy issues.*

Comparison of Options

The expected 'performance' of each of the options relative to Option 1 - No Policy Change was rated against an agreed set of nine criteria. To improve the clarity of the analysis, each of these criteria was defined in terms of three sub-criteria.

Each of the 27 sub-criteria was rated using a simple system:

-	*Option likely to result in a negative impact*
0	*No change from Option 1*
+	*Option likely to result in a positive impact*

Although the analysis was based on the assumption that each of the criteria (and associated sub-criteria) would carry an equal weight, inspection of the results suggests that the overall results are relatively insensitive to the weighting of individual criteria. This, in turn, suggests that although some differences in the relative weighting of criteria under the different demand scenarios would be expected, the overall results are likely to remain unchanged.

The overall results were that, in the longer term, further consideration should be given to a Community Agency (Option 3) or an EU Agency (Option 4). The Community Agency has positive impacts because it encourages EU cohesion, provides an EU 'voice' as well as being generally 'efficient'. While an EU Agency offers similar attractions, its main strength is its ability to deal with defence and dual-use issues. In contrast, an Executive Agency (Option 5), while offering efficiencies in programme implementation lacks the ability to deal with political and defence issues. As a consequence, there is little merit in pursuing this option further.

In the shorter term, the Revised ESA/EC Framework (Option 2) provides a 'half-way house' by offering advantages over the existing situation and allowing further development of the longer term options to be undertaken. In particular, further consideration will need to be given to dealing with defence and dual-use issues. Although there may be arguments for and against a Community or EU Agency, there are other possibilities which could be considered including an Agency which spans two (or even three) pillars or, potentially, the reallocation of defence-related space issues to the European Defence Agency.

CONTENTS

CONTENTS (CONT.)

GLOSSARY

ASD	AeroSpace and Defence Industries Association of Europe
BAU	Business as Usual
BSS	Broadcasting Satellite Services
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CASIC	China Aerospace Science and Technology Corporation
CFSP	Common Foreign and Security Policy
CGEA	Community General Export Authorisation
COTS	Commercial Off-the-Shelf
DAB	Digital Audio Broadcasting
DBS	Direct-to-home Television Broadcasting
DGs	Directorates General (of the Commission)
DOS	Department of Space (India)
DTH	Direct to Home
DVB-RCS	Digital Video Broadcast – Return Channel Satellite
EADS	European Aeronautic Defence and Space Company
EBITDA	Earnings before Interest, Taxation, Depreciation and Amortisation
EC	European Community
ECI	European Components Initiative
ECSS	European Cooperation for Space Standardisation
EDA	European Defence Agency
EGNOS	European Geostationary Navigation Overlay Service
EO	Earth Observation
ESA	European Space Agency
ESDP	European Security and Defence Policy
ESP	European Space Policy
ESTMP	European Space Technology Master Plan
ETSI	European Telecommunications Standardisation Institute
EU	European Union
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EUSC	European Union Satellite Centre
FP6/FP7	Sixth/Seventh Framework Programme (for Research)
FP7 EA	FP7 Implementation Executive Agency
FSS	Fixed Satellite Services
GATS	General Agreement on Trade in Services

GLOSSARY (CONT.)

GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GEO	Geostationary Orbit
GIS	Geographic Information System
GJU	Galileo Joint Undertaking
GLONASS	Russian Global Navigation Satellite System
GMES	Global Monitoring for Environment and Security
GNSS	(European) Global Navigation Satellite System
GPS	(US) Global Positioning System
GSLV	Geo-synchronous Launch Vehicle
HEO	Highly Elliptical Orbit
HDTV	High Definition Television
ILS	International Launch Services (US-Russian)
IP	Internet Protocol
ISRO	Indian Space Research Organisation
ITAR	US International Trade in Armaments Regulations
ITU	International Telecommunication Union
LEO	Low Earth Orbit
MEO	Medium Earth Orbit
MSS	Mobile Satellite Services
OECD	Organisation for Economic Co-operation and Development
OHB	Otto Hydraulic Bremen GmbH
OSHA	European Agency for Safety and Health at Work
PECS	Plan for European Cooperating State
PFI	Private Finance Initiative
PPP	Public-Private Partnership
R&D	Generic term for Research & Development as used in this report
RKA	Russian Federal Space Agency
SMEs	Small and Medium Enterprises
SSTL	Surrey Satellite Technology Ltd
TBL	To be Launched
USML	US Munitions List
VSAT	Very Small Aperture Terminal
WTO	World Trade Organisation

1. INTRODUCTION

1.1 Background to Study

The European Commission and the Council of the European Union are committed to a growing European Community involvement in space-related research and development. This includes research and development into satellite technologies and applications, the introduction of operational satellite systems and the development of clear policies on space-related issues (including at the international level).

The Commission is also working in increasingly close cooperation with the European Space Agency (ESA) and these two bodies (the Commission and ESA) are currently drafting a European Space Policy (ESP) and an associated European Space Programme, in consultation with Member States of the EU. The aim of the ESP is to increase the effectiveness of activities in Europe in achieving economic and strategic benefits and to improve the efficiency with which these are delivered, for example through an increased use of space-based systems and increased investment in relevant technologies and operational systems.

Against this background, there have also been considerable changes in the structure of markets for space-related goods and services. This includes both shifts in demand for particular types of technologies (satellite systems) and in the composition of the companies supplying the different sub-sectors. In general, the industry is comprised of a highly diverse set of organisations involved in both the demand and supply of goods. It is also likely to be characterised by a complex supply chain including defence contractors, niche companies producing small and specialist satellites, software houses and security-related expertise.

More generally, promoting the development of space technologies in Europe and ensuring that the desired long-term economic and strategic benefits of such activities are achieved will require the sharing of tasks and responsibilities between public and private sector organisations. This in turn will have to rely on the establishment of clear roles for the various international, national and private sector organisations. The structures for effective political and operational/programme governance must therefore be clearly defined. Although several different governance scenarios can be hypothesized, they are likely to have different implications to the future development of European space capabilities. They may also require changes in the existing legal frameworks and longer-term changes in current institutional arrangements.

1.2 Study Objectives

In developing the ESP, the Commission must prepare an assessment of the impacts associated with the different policy options under consideration. Under the Framework Contract on Impact Assessments (Entr/04/093, Lot 2), Risk & Policy Analysts Ltd (RPA) has been contracted to undertake a study to assist the Commission in preparing a rigorous analysis of the different options.
As indicated in the Task Specifications, the objectives of this study were:

- to assemble information on the principal markets for space and space-related hardware and services and a range of realistic scenarios for market development;
- to establish the ability of the European industry to achieve a significant share of profitable sales in those markets which are accessible and identify factors within the European Space Policy which may affect that position; and
- to consider the roles which key public sector actors in Europe have in influencing the competitiveness of the industry and assess the impact of different options for organising public sector activities.

1.3 Approach to the Study

The study involved three phases comprising: the analysis of market data and the development of demand scenarios; assessment of the scenarios, analysis of models for their future management, and regulations that affect industry activities; followed by final reporting.

The approach to the study was agreed at the Start-up Meeting held in Brussels on 12 July 2006. The study was made up of nine tasks (in three phases) and the progress of each is summarised in Table 1.1.

Work on the first four tasks (Phase 1) was reported on in the Preliminary Report (submitted 25 August) and discussed at the First Review Meeting (6 September). Following the First Review Meeting, the Preliminary Report was revised and re-submitted on 18 September. Work on the progress of the second four tasks (Phase 2) was reported on in the Interim Draft Report (submitted 30 October) and discussed at the Second Review Meeting (15 November). Following the Second Review Meeting, the Interim Draft Report was revised and re-submitted on 30 November.

The Draft Final Report (submitted 14 January 2007) presented the results on the remaining work undertaken in Phase 2 as well as providing a full report on all the work undertaken (Phase 3). This work included detailed consultation with a range of key stakeholders on the issues associated with regulations and governance as well as an analysis of options for future institutional arrangements. Following the Third Review Meeting (8 February 2007), the analysis presented in the Draft Final Report was revised and this Final Report presents the final output from the study.

Table 1.1: Approach and Status of Study by Task		
Task	**%Complete**	**Comment**
Phase 1: Task A: Project Scoping	100%	Start-up meeting held (12 July) and minutes circulated.
Task B: Analysis and Summary of the Space Market	100%	Detailed analysis presented in the Preliminary Report with revisions/updates made in the Interim Draft Report.
Task C: Compilation of Demand Scenarios	100%	Review and selection of future demand scenarios originally presented in the Preliminary Report. Reviewed and revised following First and Second Review Meetings (September and November). Further revisions presented in the Draft Final Report.
Task D: Selection of Demand Scenarios	100%	
Phase 2: Task E: Scenario Analysis	100%	Implications of demand scenarios on satellite markets and key stakeholders explored under each demand scenario. Preliminary analysis presented in Interim Draft Report and completed in the Draft Final Report, with some revisions in this Final Report.
Task F: Analysis of Alternative Management Models	100%	Preliminary review of current ESA/EC framework and alternative models presented in Interim Draft Report. Models evaluated against criteria under different scenarios in the Draft Final Report. Analysis revised in this Final Report.
Task G: Analysis of Impacts of Regulation	100%	Detailed review of relevant regulations presented in Interim Draft Report. Further work including results of consultation presented in the Draft Final Report with some further revisions in this Final Report.
Task H: Interim Reporting, Discussion and Commenting	100%	Results of Tasks E-G to November (as well as revisions to Tasks B-D) presented in the Interim Draft Report.
Phase 3: Task I: Final Reporting	100%	The Draft Final Report has been revised to this Final Report.

1.4 Structure of this Report

This is the Final Report, covering the work completed for Tasks A to I. The Report includes:

- an analysis and summary of the present space market, based on published sources, in Section 2;
- a review of the impacts of current regulations on the European space industry in Section 3;
- Section 4 presents four future demand scenarios and assesses the potential impacts on key stakeholders;
- an analysis of alternative management models is set out in Section 5; and
- a summary of the key findings is presented in Section 6.

2. THE CURRENT SPACE MARKET

2.1 Introduction

As for all industry sectors, the space sector[2] can be discussed in terms of demand and supply. On the demand side, two main elements are commonly identified (OECD, 2004; Euroconsult, 2004):

- the institutional market – which can be further divided into civilian and military markets; and
- the commercial market – which can be further divided into telecommunications, Earth observation and location or navigation based services.

The global demands of these markets are discussed first in this Section. This is followed by consideration of the supply side of the space sector, for which OECD (2004) identifies two main components:

- the upstream component, which includes manufacturers of space hardware (e.g. satellites and launchers) and providers of launch services; and
- the downstream component, which includes operators of satellites and providers of space-enabled products and services.

Many of the monetary values presented in this Report are given in US dollars ($). This is because the US dollar has been used in the majority of the existing studies, and thus forecasts, of the global space industry. Fluctuations in the value of the US dollar relative to the Euro in recent years mean that any attempts to convert the figures to Euro will result in inconsistencies. However, this is addressed further in relation to the institutional markets below.

2.2 Global Demand

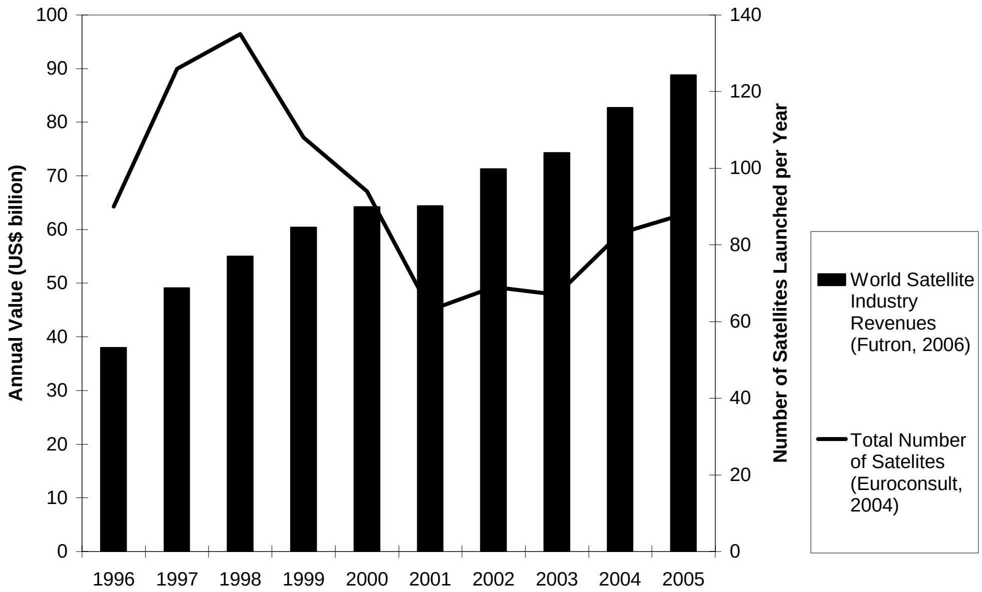
2.2.1 Overview

The overall economic value of the global space sector is difficult to determine, since it depends upon the definition of the sector adopted and the data source selected. However, the current annual turnover of the sector would appear to be in the region of $90 to $100 billion.

The world satellite industry revenues given in Futron (2006) cover satellite manufacturing, the launch industry, satellite services and ground equipment and, as illustrated in Figure 2.1 (overleaf), these place the value of the global space sector at around $90 billion in 2005.

[2] Which can be defined as organisations (private, public, and academic) whose activities rely on the development and use of space assets and/or space data (CSA, 2000). This includes satellite and launcher manufacturers, operators and service providers.

Figure 2.1: Indicative Value of the Global Space Sector and Total Number of Satellites Launched 1996-2005



In 2004, Euroconsult estimated that commercial value-added services in telecommunications, Earth observation and navigation were around \$64 billion (€55 billion[3]) in 2003. Combined with institutional expenditure of around \$31 billion[4] in 2003, this gives a 2003 market estimate of \$95 billion, compared to Futron's estimate of \$83 billion for the world satellite industry revenue in 2003. Whilst there will be some overlap between the institutional budgets and the revenue of commercial companies, the sector value may also encompass more than is defined as the satellite industry by Futron (2006). This is further illustrated by the suggestion in CEC (2005a) that the global *space applications-related market* will be around €350 billion by 2010. However, Figure 2.1 clearly illustrates that the global space sector is growing, with Futron (2006) reporting that world satellite industry revenues had an average annual growth of 6.7% for the period 2000-2005.

Demand for satellites, and consequently for launch services, stems from the development of numerous applications, which are provided by three categories of satellite operators (Civil, Military and Commercial) and from three main types of orbit (geostationary (GEO), Low Earth Orbit (LEO), and Medium Earth Orbit (MEO), which includes highly elliptical orbits (HEO)), as indicated in Table 2.1 (overleaf). It is of note that this Table is based on traditional satellite applications (fixed and mobile; voice, voice and data, narrowband and broadband) and excludes several futuristic services (space tourism, in-orbit production, manned planetary mission, etc) that could be introduced in the future.

3 Based on an exchange rate of €1 to \$1.16 on 31 October 2003, www.federalreserve.gov.

4 In 2002, Euroconsult estimated that, on average, 70% of civil institutional budgets for space were spent outside national space agencies. Therefore 70% of a \$44 billion institutional budget in 2003 was expenditure to industry and the academic world, valued at \$31 billion.

Table 2.1: Major Categories of Satellite Applications by Orbit and Operator

Application	Satellite Operators			Orbits			
	Civil Govt	Military Govt	Commercial Companies	Deep Space	LEO	MEO/ HEO	GEO
Fixed communications	+	++	+++		y	y	y
Television broadcasting	+	+	+++				y
Radio broadcasting	+	+	++			y	y
Mobile telephony	+	+	+++		y	y	y
Messaging/paging	+	+	++		y	y	y
Navigation	++	++	+		y	y	y
Search & rescue	++	+	+		y	y	y
Earth observation	+++	+++	++		y		
Meteorology	+++	++			y		y
Electronic intelligence		+++			y		y
Early warning		+++			y		y
Data relay	+++	+++			y	y	y
Technology demo	+++	+++	+		y	y	y
Science	+++			y	y	y	y

Note: +++: a core activity; ++: an important activity; +: a marginal activity; no +: no activity
Source: Euroconsult, 2004

The characteristics of the three markets, Civil, Military and Commercial, are discussed below.

2.2.2 Institutional Civil, Military and Commercial Markets

Civil Markets

The institutional market is vital to the space industry as it provides a large, stable source of revenue and it is often a captive market to the domestic industry, i.e. strong competition from foreign suppliers may be prevented. Civilian agencies contract R&D and procure space hardware (satellites, launchers, in-orbit infrastructures) in the framework of their programmes (science, telecom, observation, meteorology, navigation, technology, access to space and human space flight) and the total value of the global civil market in 2004 was nearly $27 billion. Although the share of GDP spent on space by governments has declined over the last decade (OECD, 2004), budgets are still rising, with an average growth of 4% annually from 2000 to 2004 (Euroconsult, 2005a). This has been driven mainly by economic growth in the US, Europe and Japan (OECD, 2004).

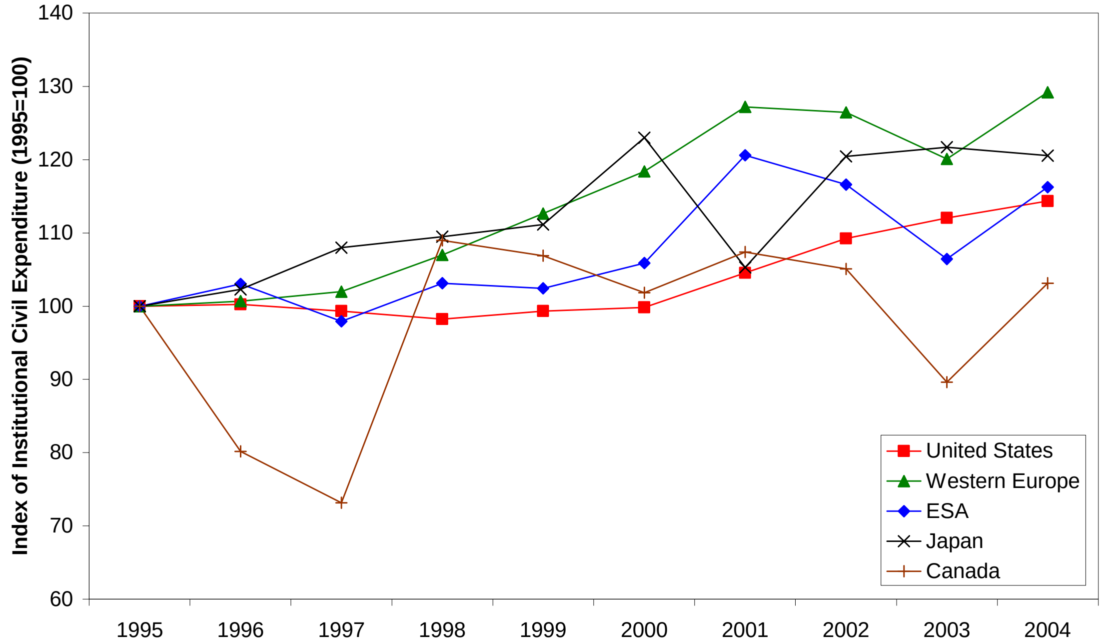
Civil space programmes are more commonly implemented than military space programmes, with three times more civil entities than military agencies investing in space programmes. This is reflected in total institutional budgets, although not in the same proportion, with 57% of governments' allocations derived from civil authorities. Although the number of countries involved in space programmes is growing, the gap between the national allocations is significant, with 80% of the world's expenditure concentred in five countries (based on $), as shown in Table 2.2. Or, in terms of space programmes, 95% of civil funding is received by the US, Europe (the European Space Agency (ESA)) and Japan (Euroconsult, 2005a).

Table 2.2: Institutional Civil Budgets for Space Activities (Index: 1995=100)							
		2000	**2001**	**2002**	**2003**	**2004**	**Cumu-lative Share**
United States	Actual US$ in millions	13,562	14,194	14,921	15,382	15,870	59%
	Index	*103*	*108*	*113*	*117*	*120*	
Western Europe	Actual US$ in millions	4,643	4,836	5,072	5,767	6,726	
	Actual € in millions	5,020	5,395	5,362	5,094	5,480	
	Index	*118*	*127*	*126*	*120*	*129*	
ESA	Actual US$ in millions	2,937	3,243	3,307	3,615	4,279	
	Actual € in millions	3,176	3,618	3,496	3,193	3,486	
	Index	*106*	*121*	*117*	*106*	*116*	
Japan	Actual US$ in millions	2,504	2,155	2,180	2,257	2,512	68%
	Actual Yen in billion	278	238	272	275	272	
	Index	*123*	*105*	*120*	*122*	*121*	
France	Actual US$ in millions	1,687	1,645	1,734	1,894	2,033	76%
	Actual € in millions	1,824	1,834	1,834	1,673	1,656	
	Index	*102*	*102*	*102*	*93*	*92*	
Italy	Actual US$ in millions	575	706	811	958	897	79%
	Actual € in millions	622	787	857	846	731	
	Index	*146*	*185*	*202*	*199*	*172*	
Germany	Actual US$ in millions	612	614	674	782	870	82%
	Actual € in millions	662	685	713	691	709	
	Index	*89*	*93*	*96*	*93*	*96*	
India	Actual US$ in millions	425	406	449	489	608	84%
	Actual Rupees in millions	19,054	19,141	21,799	22,746	27,314	
	Index	*208*	*209*	*238*	*248*	*298*	
Russia	Actual US$ in millions	169	195	310	298	476	86%
	Actual Roubles in millions	4,740	5,691	9,742	9,151	13,688	
	Index	*357*	*429*	*734*	*689*	*1031*	
United Kingdom	Actual US$ in millions	269	244	241	309	361	88%
	Actual £ in millions	177	169	160	189	198	
	Index	*91*	*87*	*82*	*97*	*102*	
Canada	Actual US$ in millions	215	217	210	201	241	88%
	Actual CAN$ in millions	319	336	329	281	323	
	Index	*102*	*107*	*105*	*90*	*103*	
Spain	Actual US$ in millions	119	111	120	147	199	89%
	Actual € in millions	129	124	127	130	162	
	Index	*123*	*119*	*122*	*125*	*156*	
World Total	**Current US$ in millions**	**21,915**	**22,446**	**23,536**	**24,872**	**26,978**	**100%**

Note: Western Europe is shown for illustrative purposes and includes France, Germany, UK, Italy, Austria, Belgium, Denmark, Finland, Ireland, Netherlands, Norway, Portugal, Sweden, Switzerland and Spain.
Source: Euroconsult (2005a)

However, it should be noted that a comparison of institutional expenditure, based on US dollars, can misrepresent recent trends, due to fluctuations in the US$ exchange rate (most notably with the Euro). For example, civil expenditure in Western Europe has increased much slower when considered in its original currency (Euro) compared to the US$ equivalent. For this reason, Table 2.2 and Figure 2.2 illustrate an indexed civil institutional expenditure, where 100 equals the expenditure in 1995 in the original currency. From this it can be seen that European expenditure has increased relatively more than US expenditure over the past ten years.

Figure 2.2: Indexed Institutional Civil Expenditure 1995-2004
(based on Euroconsult, 2005a)

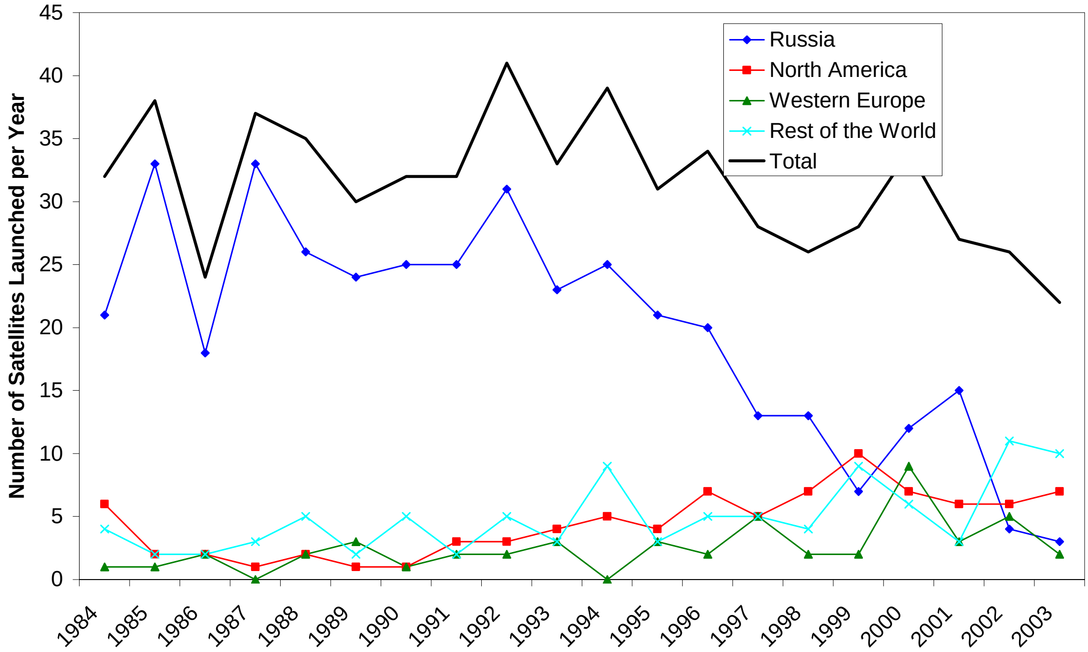


Overall, 27 national civil budgets exceed the $10 million mark, and there are another 30 ‘emerging’ countries which have decided to introduce space technology into their global development policy, thereby potentially introducing new markets. Euroconsult (2005a) suggests that most of these newcomers will focus on programmes from which they can get direct benefits, which are mainly telecommunications and observation. Some may also favour science and technology programmes in order to develop local industrial/ technological capabilities.

In countries such as China, India and Russia, the space industry is thought to have developed significantly in recent years in terms of technology, capabilities and service provision. Unfortunately, with most of the investment being military based, many countries do not publish figures or details of their current space programmes (civil or military). It is also difficult to isolate space elements in defence and civil budgets. Annex 2 to this Report provides a summary of what is known about these countries’ space industries based on published sources and the use of industry experts. This estimates that civil expenditure in China may be in the region of US$1 billion, US$900 million in Russia, and around US$470 million in India. It is noted that these estimates vary from those presented by Euroconsult (2005a) due to the use of different data sources, and thus illustrate the uncertainty that surrounds such space programmes.

Figure 2.3 illustrates the number of civil satellites launched between 1984 and 2003 by the key markets of North America, Western Europe and Russia, as well as the rest of the world. The dominance of Russia in the 1980s and 1990s (due to, generally, short-lived, low capacity satellites) has reduced in recent years and the markets are now more similar in terms of the number of launches.

Figure 2.3: Number of Civil Satellites Launched by Region 1984 – 2003
(source: Euroconsult, 2005a)

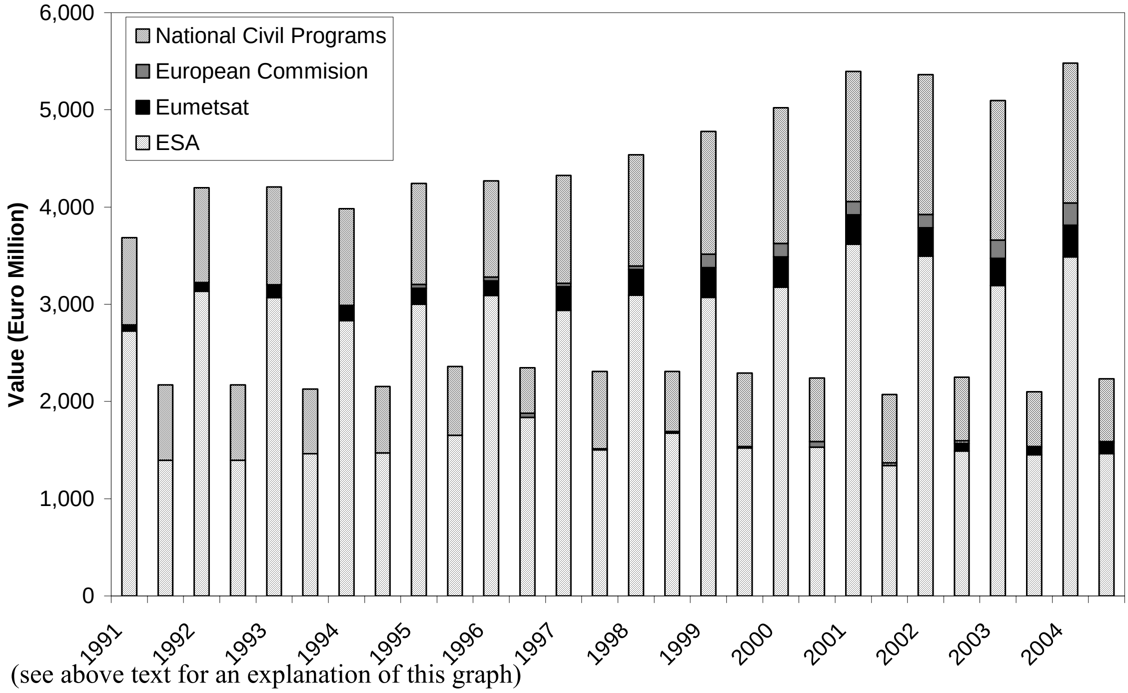


European institutional civil markets include the European Space Agency (ESA), national space agencies, EUMETSAT, European Commission contracts and multilateral civil projects such as Jason. Figure 2.4 (overleaf) illustrates the relative budgets of these civil institutions (based on Euroconsult, 2005a) in the first column for each year. The second column for each year relates to the European industry revenue from civil customers (based on ASD-Eurospace, 2006). The difference between these figures is due to a number of reasons, which are generally data related:

- Euroconsult notes that around 70% of public budgets represent purchases from industry;
- the ASD-Eurospace figures only consider the turnover of the space manufacturing industry; operators and service providers (including, for example, launches by Arianespace) are not included in the industry figures;
- ASD-Eurospace provides data for 15 European countries, which, whilst accounting for the majority of the European industry, excludes some countries which have civil budgets and which receive ESA contracts;

- it is noted that a proportion of European civil budgets are spent outside of Europe – this may be the case where figures include US and Russian launches of European satellites; and
- there appear to be some data discrepancies which are difficult to resolve.

Figure 2.4: Institutional Budgets and Space Manufacturing Industry Turnover associated with European Institutional Civil Customers 1996-2005
(source: Euroconsult, 2005a and ASD-Eurospace, 2006)



(see above text for an explanation of this graph)

Public-Private Partnerships (PPPs) have been used as an alternative to financing space programmes where government money may be short. PPPs provide a framework whereby the government body contracts out the whole or part of the design, construction, operation and/or financing of a public service infrastructure, to the private sector. PPPs are increasingly considered by governments to finance their civil and military space systems, and at least seven space programmes are currently in progress under PPP, mainly in Europe but also in Japan. Through PPP ventures, governments hope to reduce costs by taking advantage of private sector management skills and by giving the private sector an incentive to keep costs under control (Euroconsult, 2005a).

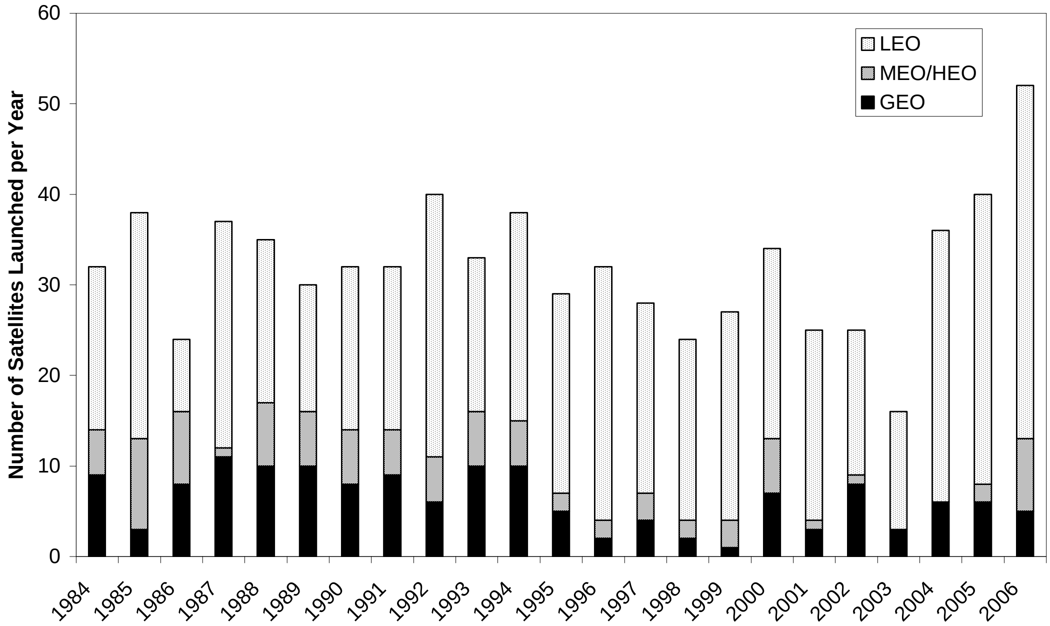
In general, the main civilian markets (US, Europe, Japan and India) have concentrated on the development of applications which have direct benefits to end-users (e.g. telecommunications, navigation, Earth observation and meteorology). These applications accounted for 44%[5] of expenditure in 2004, compared to 33% in 1990. In comparison, science (e.g. space science, human space flight and the space shuttle) budgets are decreasing over time, with 27% in 2004 compared to 33% in 1990. The

5 This excludes NASA expenditure – NASA's exclusive scientific mandate, and budget size, distorts the proportions spent by other civil agencies.

remaining budget is spent on launchers (22%) and technology development (8%) (Euroconsult, 2005a).

Figure 2.5 illustrates the number of civil satellites launched into different orbits, which is dominated by LEO satellites. As illustrated in Table 2.1, LEO is the key orbit for Earth observation applications. GEO satellites are used by government agencies for public service missions, including telecommunications, meteorology and technology demonstration.

Figure 2.5: Number of Civil Satellites Launched by Orbit 1984 -2006*
(source: Euroconsult, 2004)



**2004-2006 are estimates*

Military Markets

Military agencies may either procure satellites and launchers and operate their own satellite fleet or they may choose to lease capacity to a privately-owned satellite system dedicated to military purposes or to a commercial satellite (Euroconsult, 2005a).

In 2004, the total value of the global military market was nearly $20 billion. In recent years, the military market has grown more quickly than the civil market, at a rate of over 7% annually from 2000-2004. Whilst government spending for both civil and military applications has been increasing since the late 1990s, it is noticeable that the growth of the US space budget, particularly for military applications, has a significant effect on the global picture (Euroconsult, 2005a).

In contrast to civilian applications, military space applications are a very specific area that requires a certain degree of maturity in the development and use of space technology. The structure of the market is therefore quite different to the civil market, with only a limited number of participants (France, Belgium, Germany, Italy, Spain, UK, Russia, Israel and China) funding military space applications, and the market is concentrated within the US which has 94% of the global budget (Euroconsult, 2005a). The military budgets of each country are summarised below in Table 2.3.

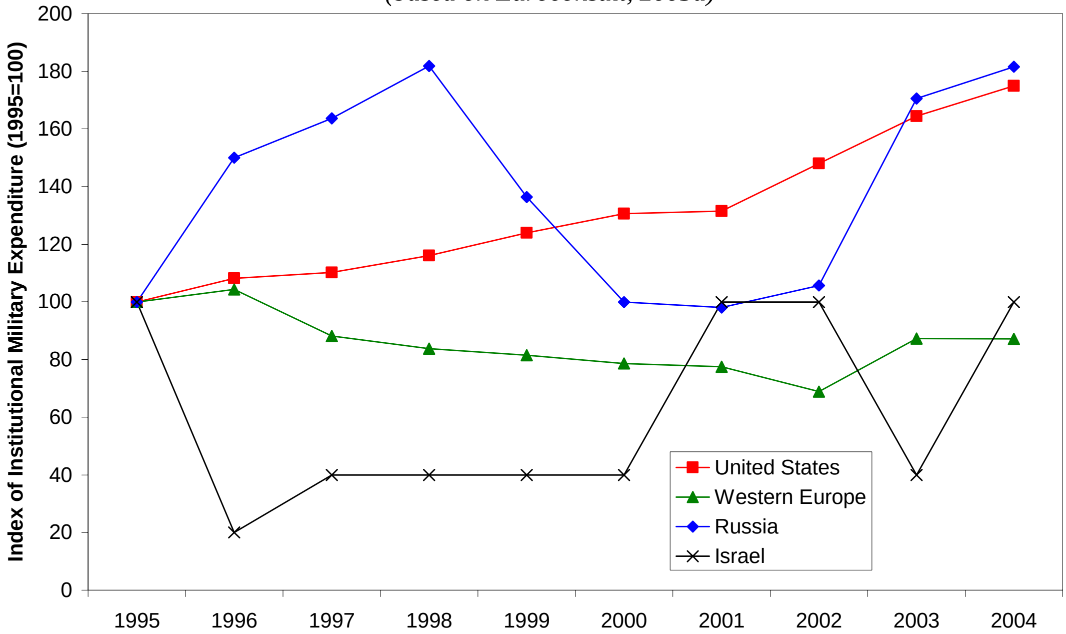
Table 2.3: Institutional Military Budgets for Space Activities (Index: 1995=100)

		2000	2001	2002	2003	2004	Cumu-lative Share
United States	Actual US$ in millions	13,900	14,000	15,750	17,500	18,625	93.7%
	Index	*131*	*132*	*148*	*164*	*175*	
Western Europe	Actual US$ in millions	622	595	557	846	916	
	Actual € in millions	673	664	589	747	746	
	Index	*79*	*78*	*69*	*87*	*87*	
France	Actual US$ in millions	323	373	424	492	493	96.2%
	Actual € in millions	350	416	448	435	402	
	Index	*57*	*68*	*74*	*71*	*66*	
United Kingdom	Actual US$ in millions	100	100	45	240	*240*	97.4%
	Actual € in millions	109	112	48	218	*218*	
	Index	*70*	*72*	*31*	*141*	*141*	
Russia	Actual US$ in millions	110	108	116	188	200	98.4%
	Index	*100*	*98*	*106*	*171*	*182*	
China	Actual US$ in millions	66	131	131	131	131	99.1%
	Actual Yuan in millions	1440	680	680	680	680	
	Index	*3600*	*1700*	*1700*	*1700*	*1700*	
Germany	Actual US$ in millions	44	45	52	68	37	99.3%
	Actual € in millions	48	50	55	60	30	
	Index	*145*	*151*	*167*	*182*	*91*	
Italy	Actual US$ in millions	150	75	30	43	58	99.6%
	Actual € in millions	162	84	32	38	48	
	Index	*324*	*167*	*63*	*76*	*95*	
Israel	Actual US$ in millions	20	50	50	20	50	99.8%
	Index	*40*	*100*	*100*	*40*	*100*	
Spain	Actual US$ in millions	21	20	30	30	30	100%
	Actual € in millions	23	22	32	26	24	
	Index	*117*	*115*	*164*	*137*	*126*	
Belgium	Actual US$ in millions	10	28	14	30	30	100%
	Index (2000=100)	*100*	*278*	*139*	*300*	*300*	
World Total	**Actual US$ in millions**	**14,836**	**14,863**	**16,570**	**18,666**	**19,873**	**100%**

Note: Western Europe is shown for illustrative purposes and includes France, Germany, UK, Italy, Belgium and Spain.
Source: Euroconsult (2005a)

As for the civil budgets, use of US$ may misrepresent recent (particularly European) trends, therefore Table 2.3 and Figure 2.6 (overleaf) provide indexed institutional military budgets, where 1995 equals 100 (except for Belgium). Figure 2.6 presents the indexed expenditure of the key military markets (except China, where the indexed figure is less robust). Alternative figures for China, Russia and India are presented in Annex 2, where these are based on a range of published sources and expert opinion. For China, in particular, estimates place the military market at least 20 times higher than that given in Table 2.3, at US$2-3 billion.

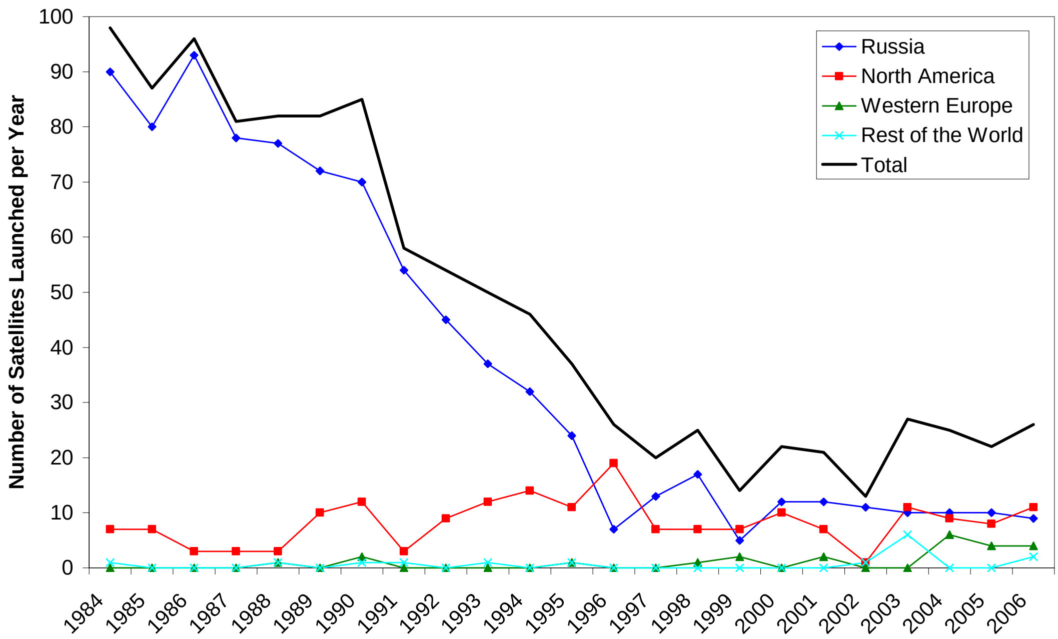
Figure 2.6: Indexed Institutional Military Expenditure 1995-2004
(based on Euroconsult, 2005a)



(Note: Indexed figures for Russia and Israel are based on US$)

Recent increases in the US defence budget (+25% between 2001 and 2002) have only accentuated the gap between the US and the rest of the world in this regard. Whilst Figure 2.7 suggests that Russia has, at least in the past, a more dominant position when considering the number of military satellites launched, Euroconsult (2005a) suggests that its military space programme remains affected by serious gaps and an unstable financial basis. Furthermore, military procurement of space assets in Europe tends to be on a national basis; therefore, a limited number of projects with high value add to market fluctuations.

Figure 2.7: Number of Military Satellites Launched by Region 1984–2006*
*(source: Euroconsult, 2005a) *2004-2006 are estimates*



The gap between the US and Europe in terms of military space capability and maturity is a major point of concern in Europe. Euroconsult (2005a) summaries the situation as follows:

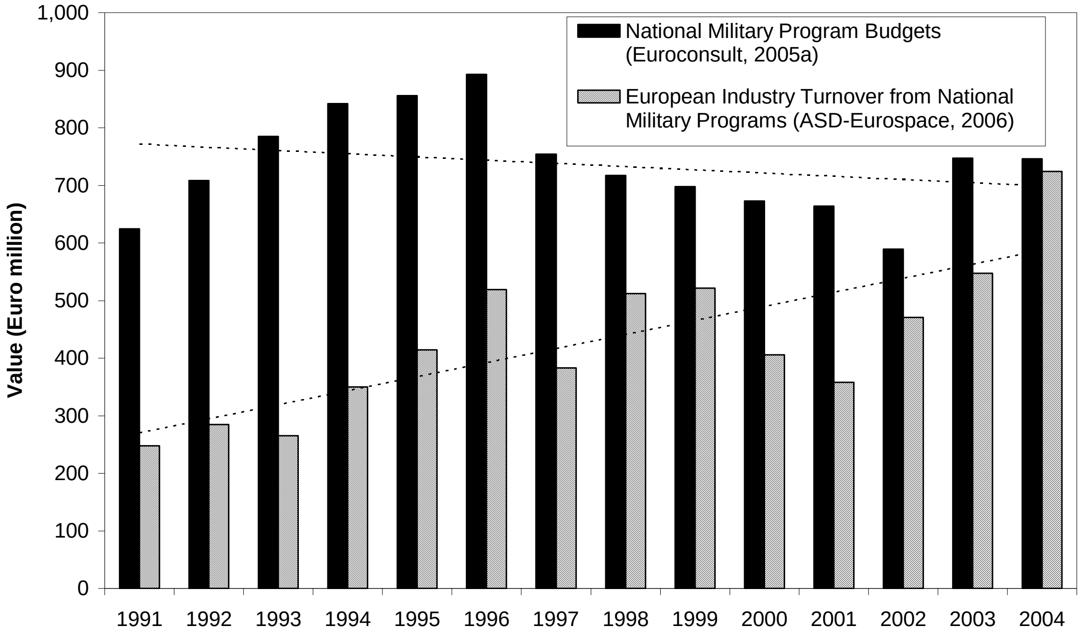
- the cumulative budget of European countries in military space activities of \$916 million in 2004 is a factor of 20 below that of the US. The US has also maintained a space programme and much higher investment over a much longer period of time compared to Europe;
- the general defence budget in the US is, however, only 2 to 3 times greater than that in Europe, suggesting that the differences in the military space markets are largely due to different views on the effectiveness and potential use of space assets for military purposes;
- funding in Europe is nationally based, resulting in a duplication of research and development in addition to being less efficient than a collective effort. Funding is also highly correlated to individual projects and therefore highly cyclical, focussed on only a few programmes at any single point in time;
- in contrast, the US invests widely in a larger range of application fields simultaneously, while Europe focuses only on telecommunications and surveillance technology. This is also related to funding, as it is the scale of US spending that allows for such investment compared to Europe; and
- RPA (2006) notes that the absence of a collective funding and management body for production, research and development of space technologies in the military sector, similar to the ESA, prevents efficient and effective development of the industry. The European Defence Agency (EDA) is moving in this direction, but is only in its infancy, having commenced activities in 2004, and is restricted by a very limited budget. Part of the progress made recently includes the establishment of a Space Assets Group within the European Capabilities Action Plan (ECAP) aimed at identifying and filling gaps in military software and hardware programmes.

European military interest in space applications has been rather small in the past because there was little involvement of European military forces in overseas operations and therefore low demand. For many years, France and the UK were the only two countries with domestic military satellite systems, while others accessed third party capacities. In the late 1990s, several European countries identified space assets as a key gap in their military equipment and considered that securing autonomous access to satellite capacities was a top priority. However all programmes have been pursued under national initiatives, resulting in duplicated investment and redundant capabilities at a time of scarce funding (Euroconsult, 2005a).

Figure 2.8 (overleaf) illustrates Euroconsult's (2005a) data which suggest that European military space budgets have been declining slowly over time, from €900 million in the mid-1990s to €590 million in 2002. In contrast, the European space manufacturing industry has received an increasing turnover from national military programmes (ASD-Eurospace, 2006). <u>This comparison is subject to the same caveats set out on page 10 in relation to civil institutional budgets</u>, where the industry figures do not account for the whole sector and/or some expenditure may be outside of Europe, e.g. for non-critical components.

Figure 2.8: Institutional Budgets and Industry Turnover associated with European Institutional Military Customers 1996-2004

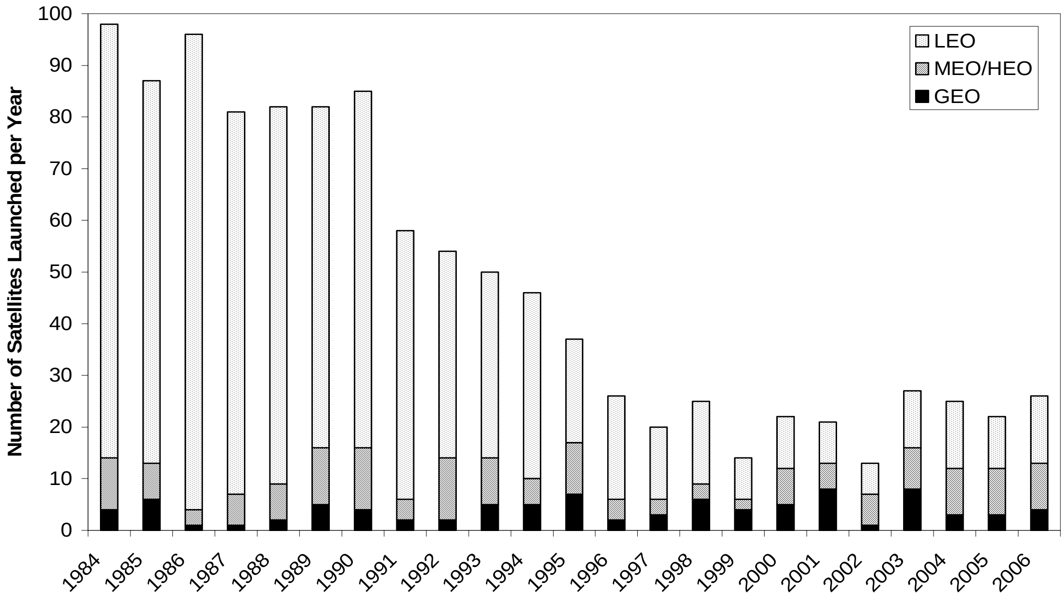
(source: Euroconsult, 2005a and ASD-Eurospace, 2006)



As for the civil markets, and to compensate for lower funding, Private Finance Initiatives (PFI) schemes have been implemented in many countries including Spain, Italy and the UK. Dual-use technologies have also been used as a means of funding military projects, for example, the military may purchase data from the commercial operators of satellites, for military purposes or contribute financially to the satellite's development.

Figure 2.9 (overleaf) illustrates the number of military satellites launched to different orbits, with the general decrease in total numbers of satellites reflecting the trend in the Russian market shown in Figure 2.7. Although a large proportion are LEO satellites, military applications account for the majority of MEO/HEO satellites launched (61% of the 218 MEO/HEO satellites launched between 1984-2003); most of these were GPS and Glonass satellites (Russia's navigation satellites).

Figure 2.9: Number of Military Satellites Launched by Orbit 1984 -2006*
*(source: Euroconsult, 2004) *2004-2006 are estimates*



Commercial Markets

The commercial market covers three key segments (Euroconsult, 2004):

- telecommunications and broadcasting;
- Earth observation and geographic information; and
- location and navigation (services only, as hardware are accounted for under civil or military markets).

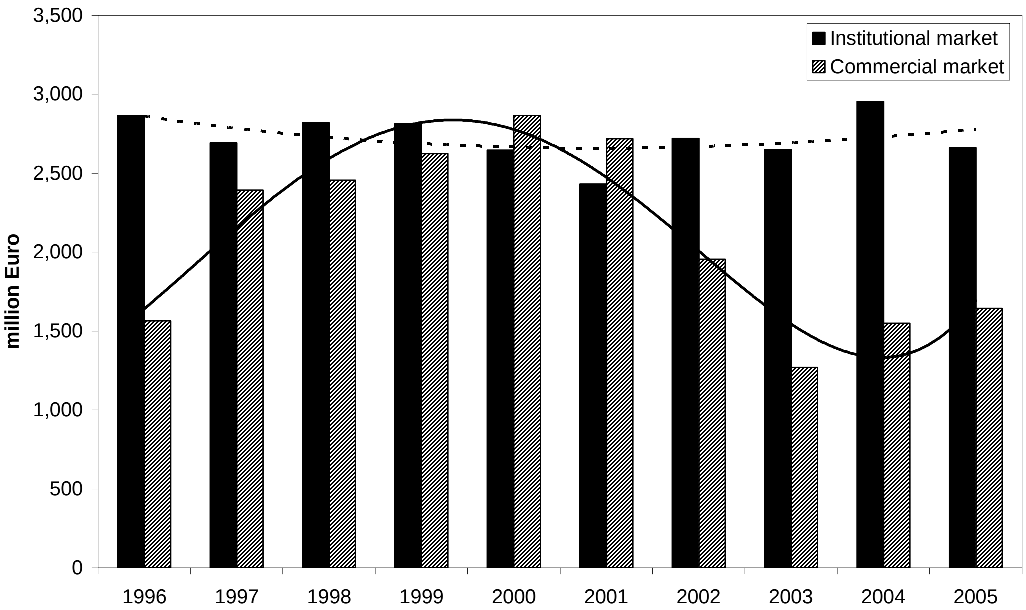
It is of note that (near) future applications may combine two or more of these segments, however, for simplicity, these markets are considered individually here.

Of these three segments, the value chain for communications satellites is the most developed, as the telecommunications and broadcasting industries have been using satellite systems for 30 years. The commercial Earth observation and navigation markets are emerging, with business models that differ from the communications model, as the satellite information has limited economic value per se, if it is not integrated into value-added services.

In this context, the size of the commercial market is less easy to determine than the institutional markets, since it depends on the extent of the supply chain considered. Whilst the commercial manufacturing market is likely to be less than the institutional market (particularly when including all classified programmes), the global commercial value-added services in telecommunications, Earth observation and navigation are estimated at being worth €55 billion in revenue for the year 2003 (Euroconsult).

However, there is clear agreement that the commercial market is dominated by telecommunications and is cyclical in nature, related to the launch of new and replacement telecommunication satellites. To date, the commercial satellite market has evolved through three demand cycles, each corresponding to a new generation of spacecraft technology with improved performances. Growth in the third demand cycle has stopped in recent years because of the restructuring of the satellite operators due to market pressures. To maintain profitability (in the face of decreasing demand and overcapacity), operators had to cut capital expenditure on acquiring and launching satellites (Euroconsult, 2004). The geostationary commercial market, and other markets, have entered a low phase of their cyclical development (Euroconsult, 2004; ASD-Eurospace, 2006), however there has been some recovery over the last couple of years. This is demonstrated by the turnover associated with the European commercial market, illustrated in Figure 2.10 and compared to the more stable institutional market.

Figure 2.10: Turnover by Customer for the European Space Industry
(source: ASD-Eurospace, 2006)



Euroconsult (2004) suggest that the development of commercial satellite applications is driven by four major trends:

- **globalisation of the customer base** – regional GEO satellite operators are expanding their market coverage through mergers and acquisitions while non-GEO systems are designed from the outset to offer global coverage;
- **economic growth in developing and developed countries** – has prompted significant efforts to improve telecommunications and broadcasting infrastructures as well as Earth observation products and services;
- **deregulation in telecommunications and broadcasting markets** – strong competition on price and quality and the availability of new sources of financing have resulted in the appearance of many new users and opened many new

markets. There were 25 satellite operators in 1989; their number almost doubled to 45 in 1999. However, as markets develop, operators merge to achieve economies of scale and to cope with strong competition, market globalisation and value-added service provision which make entry costs higher; and

- **technological advances on ground and space systems –** technological advances have a fundamental impact on the satellite market as they allow new services to emerge and to become economically viable, e.g. satellite TV.

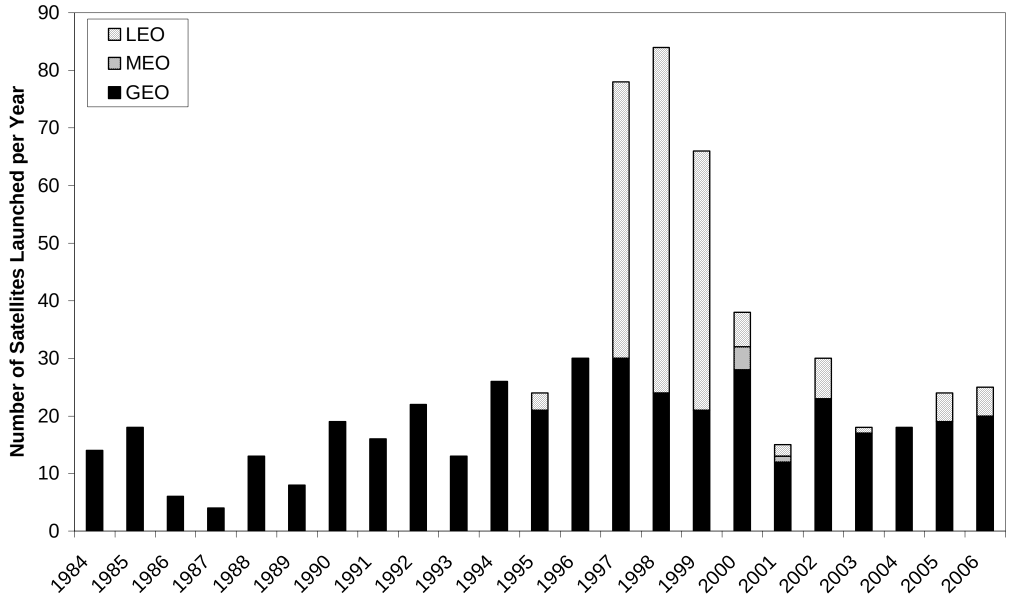
In relation to this last point, significant technological advances that have been achieved relate to (Euroconsult, 2004):

- the average bandwidth available on a satellite has almost doubled over the past ten years with currently about 1,600 MHz per satellite provided, mainly in C-band and Ku-band frequencies. The introduction of Ka-band transponders on hybrid satellites significantly increases that average;
- the operational lifetime of communications satellites has also increased, at a rate of about two years per generation, from 6-7 years in the early 1970s to 14-15 years for the satellites currently being launched; and
- the launch mass of commercial communications satellites has grown steadily, from 750kg in the early 1970s to about 2,000 kg in 1991, as a result of operator's needs and the availability of more powerful launchers. The average mass of satellites launched in 2004 was 4,000kg.

These factors may impact on industry revenues, for example, heavier satellites may result in increased launch revenues per satellite, but increased capacity by satellite may reduce the number of satellites required overall. Commercial launch activity has fluctuated based on demand from various customers. During the peak of commercial launch activity, from 1997 to 2001, commercial launches accounted for 42% of all worldwide launch activity. That share has decreased in recent years, e.g. it was 33% in 2005 (18 of 55) (AST & COMSTAC, 2006). This is discussed further in the next Section.

Geostationary satellites dominate the commercial market as they allow broad coverage, longer lifetimes and a simpler ground network than other types of satellites. However, a commercial LEO market was developed in the late 1990s that saw the launch of 182 satellites over a three year period (1997-1999) (Euroconsult, 2004). This reflects the deployment of the first three telecommunications systems ever launched into LEO – Iridium, Globalstar and Orbcomm. After their deployment, all three went bankrupt and have since exited bankruptcy with new shareholders and new business models. There have been few successful commercial launches of MEO satellites, which are an insignificant part of the market. Figure 2.11 (overleaf) illustrates the number of commercial satellites launched worldwide by orbit.

Figure 2.11: Number of Commercial Satellites Launched by Orbit 1984 -2006*
(source: Euroconsult, 2004)



**2004-2006 are estimates*

2.2.3 Main Trade Flows

Limited official data are available on imports and exports, and data from Eurostat are incomplete. The cyclical nature of the industry, with demand dependant on project-by-project procurement is also reflected in exports and imports, with some countries selling or purchasing in million of Euro one year followed by minimal expenditure the next. Furthermore, trade in spacecraft, satellites and associated technology is heavily constrained by national export controls (particularly with regard to US exports) (see Section 6) and preferences for national procurement in institutional markets. This may also extend to commercial markets where dual-use or specialist technologies are involved. Thus, a discussion of trade flows is restricted to more qualitative sources.

Recent trends include an increasing value of EU exports to countries with emerging space programmes as well as supplying established space industries in Russia and the US. For example, Zelnio (2006) discusses the change in trade flows following the introduction of the US International Trade in Armaments Regulations (ITAR), which, it is suggested, has increased the cost of doing business with US satellite manufacturers while at the same time decreasing their ability to compete in the global marketplace. Reinsch (2000) indicates that, in 1998, US satellite exports were worth US$1.06 billion, and declined by 40% to $637 million in 1999; this is suggested to be, in part at least, due to ITAR. Zelnio (2006) suggests that, since the change in US export policy, European (and other) satellite manufacturers have benefited; with orders placed by companies from China, the Middle East, Canada and the US (to be launched outside of the US) to the value of $2.5-6.0 billion. Furthermore, it is reported that China has successfully marketed it own commercial satellite bus to other countries, such as Nigeria and Venezuela, which have chosen to avoid US export policies.

In addition, the US 2000 Iran Non-proliferation Act bans the purchase of technologies from countries that do not support the US policy, which aimed at stopping Iran from acquiring nuclear weapons. This effectively banned the Russian space industry from exporting space equipment to the US, due to Russia's assistance with the building of a nuclear power station in Iran (Space Daily, 2005). However, in November 2005, US Congress amended the Act (and renamed it the Iran and Syria Non-proliferation Act) in order to remove a clause which could have caused US astronauts to lose access to the International Space Station and to retain the ability to use Russia's Soyuz spacecraft for transportation to and from the space station (Huntingdon, 2005). Thus it can be seen that the political climate can significantly affect the trade flows in space goods and services.

The Canadian Space Agency (2004) provides a breakdown of Canadian export markets, which account for 49% (CAN$1.2 billion) of the Canadian industry's revenues. The key export markets for Canada are:

- the US, representing 46% of exports;
- followed by Europe (36% or CAN$432 million);
- Asia (8%);
- South America (5%);
- Africa (2%);
- Oceania (0.3%); and
- Other (3%).

Similarly, the UK space industry identifies the US as the country offering the greatest potential for future export growth, followed by Germany, France and China (BNSC, 2006).

Within Europe, the main industrial sites are located in France, Germany and Italy, and, to a lesser extent, the UK, Spain and Belgium (ASD-Eurospace, 2006). Table 2.4 illustrates the European space manufacturing industry turnover by country which, as would be expected, mirrors the distribution of ESA commitments to industry.

Table 2.4: Space Industry Turnover by Country (2005)

Country	Space Manufacturing Industry Consolidated Turnover (2005)		Commitments to Industry by ESA (2005)	
	€ million	% of Total	€ million	% of Total
Austria	28.0	0.6%	17.9	1.0%
Belgium	111.6	2.5%	89.6	5.0%
Czech Republic	n/a	n/a	3.6	0.2%
Denmark	15.7	0.4%	17.9	1.0%
Finland	9.5	0.2%	5.4	0.3%
France	1,937.5	43.9%	680.6	38.0%
Germany	613.7	13.9%	214.9	12.0%
Greece	n/a	n/a	1.8	0.1%
Hungary	n/a	n/a	1.8	0.1%
Ireland	4.6	0.1%	3.6	0.2%
Italy	732.8	16.6%	250.7	14.0%
Luxembourg	n/a	n/a	0.2	0.01%
Netherlands	72.7	1.6%	107.5	6.0%
Norway	37.0	0.8%	17.9	1.0%

Table 2.4: Space Industry Turnover by Country (2005)				
Country	**Space Manufacturing Industry Consolidated Turnover (2005)**		**Commitments to Industry by ESA (2005)**	
	€ million	**% of Total**	**€ million**	**% of Total**
Portugal	3.6	0.1%	3.6	0.2%
Spain	180.0	4.1%	107.5	6.0%
Sweden	90.8	2.1%	35.8	2.0%
Switzerland	78.2	1.8%	53.7	3.0%
UK	501.5	11.4%	179.1	10.0%
Canada	n/a	n/a	17.9	1.0%
Total	**4,417.3**	**100.0%**	**1,791.0**	**100%***
Source: ASD-Eurospace (2006), ESA (2006)				

2.3 Satellite Manufacturers

The world satellite manufacturing industry currently includes a total of 20 companies, of which six (the main players) compete internationally for the prime contractorship of commercial GEO satellites. These are listed in Table 2.5 below.

Table 2.5: Satellite Manufacturers		
	GEO & non-GEO satellites	**Non-GEO satellites**
Satellite manufacturers competing domestically & internationally	Boeing Satellite Systems (US) Lockheed Martin (US) Space Systems/Loral (US); EADS Astrium (Europe) Alcatel Alenia Space (Europe) Orbital Science Corp (US)	SSTL (UK)
Satellite manufacturers competing domestically (mainly or exclusively)	Northrop Grumman (US) NPO-PM (Russia) RKK Energia (Russia) NPO Yuzhnoe (Ukraine) NEC-Toshiba (Japan) Mitsubishi Electric (Japan) Israel Aircraft Industry (Israel) CAST (China) ISRO (India)	General Dynamics (US) Bell Aerospace (US) McDonald Dettwiler (Canada) OHB System (Germany)
Source: based on Euroconsult (2004)		

Careless (2005) suggests that the global satellite manufacturing sector had revenues of $10.2 billion in 2004 (compared to $9.8 billion in 2003 and $12.1 billion in 2002). However, Futron (2006) report that global satellite manufacturing revenues dropped by 24% in 2005 to $7.8 billion. Given the annual fluctuations in the sector's turnover, it is useful to consider ten-year totals. Euroconsult (2004) indicates that the manufacturing market value was:

- $18 billion from 1984-1993; and
- $49 billion from 1994-2003.

Euroconsult (2004) suggest that, since the year 2000, the market balance has been shifting away from the dominance of the US companies. As of mid-2004, the two main European manufacturers of commercial geostationary satellites were controlling about 40% of the industry's backlog value, up from 20-25% in the 1990s (Euroconsult, 2004). The market forecast for GEO/HEO commercial satellite manufacturing to be launched over 2004-2013 has been valued at a minimum of $21.5 billion (Euroconsult, 2004). Of this market, $5.3 billion has already been contracted, as of mid-2004, as follows:

- Alcatel Alenia Space: $1.1 billion or 21%;
- EADS Astrium: $1 billion or 19%;
- Boeing Satellite Systems: $1 billion or 19%;
- Lockheed Martin: $0.95 billion or 18%;
- Space Systems/Loral: $0.95 billion or 18%; and
- Orbital Science Corp: $0.3 billion or 6%.

In 2005, the US share of manufacturing revenues fell to 41% (Futron, 2006). However, the European space manufacturing sector has experienced low margins, declining revenues and a reduction in employment since the year 2000 (ASD-Eurospace, 2006). Furthermore, Futron (2006) report that whilst, globally, the sector declined by 24%, US satellite manufacturing only declined by 18%, suggesting a greater decline in the European industry. This decline, globally, was due to a number of reasons, including:

- lower government contract revenues, with the average price of government payloads launched in 2005 being 69% lower than those launched in 2004 (Futron, 2006); and
- significant progress in terms of the durability and capacity of spacecraft, which has reduced the need for additional satellites (OECD, 2004).

An indication of manufacturing companies' turnover and profits is given in Table 2.6 overleaf.

There are some signs of recovery. For example, EADS Astrium received more than €600 million in telecommunications and science satellite orders in 2003 and has been able to cut further costs by restructuring (including 1,500 redundancies, 20% of the workforce); Alcatel Space and Lockheed Martin Commercial Space Systems were profitable in 2003 (OECD, 2004).

Contracting out has been an important factor in the ability of satellite manufacturers to cut costs. For instance it allowed Lockheed Martin to downsize, reducing its workforce by 40% in two years. Boeing now performs little more than 50% of the work on a commercial satellite that it wins. This is creating new business opportunities for subcontractors who do business with several prime contractors (OECD, 2004).

Table 2.6: Details of Space Manufacturing Companies 2005

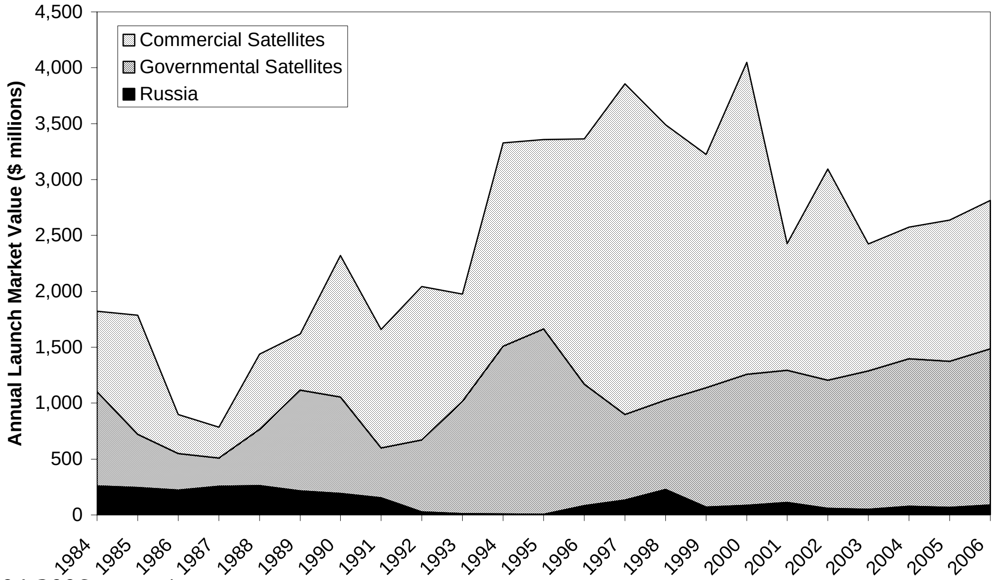
Company	Turnover ($ Million)	Operating Profit/Loss	Comment
Boeing	9,100	28.5%	Launch and Orbital System Operating Profit
Lockheed Martin	9,010	9%	Space systems division profit
Northrop Grumman	4,858	7.5%	Space systems division profit
EADS Space	3,108	2.2%	Includes EADS Astrium, EADS Space Services and EADS Space Transportation
Alcatel Alenia Space	1,776	9%	Average Alcatel profit margin
General Dynamics	720	11.1%	Space part of Information Systems & Technology division
Orbital Sciences	703	17.8%	Gross Profit margin
Bell Aerospace	629	N/A	Aerospace and Technology Segment 12% of total revenue
Loral Space & Communications	491	5.5%	Satellite Manufacturing Division
Mitsubishi Electric	354	3.2%	Average operating profit for information and communications systems division 2006
MacDonald Dettwiler and Associates	350	15.1%	Information Systems Segment
Israel Aircraft Industries	231	N/A	
OHB Technology	133	N/A	
SSTL	34	7.2%	Converted at £1=$1.90

Sources: Space News (2006a) & Company Annual Reports & SEC Filings (2005 & 2006)

2.4 Launchers Markets

While the launcher marker was quite buoyant in the 1990s, OECD (2004) notes that the demand for launching services has declined since 2000 as a result of cyclical factors and unfulfilled expectations. In 2000-2003, the world satellite industry stabilised at an average of 63 satellites launched per year; the average annual value of this market was $2.6 billion, down from a record of $4 billion in 2000. However, given annual variations, it is useful to note that the value of the launch market (institutional and commercial) over ten years (1994-2003) was $32.6 billion (Euroconsult, 2004). Figure 2.12 illustrates the launch market value by customer. The dominance of the commercial market in the late 1990s was due to the launch of three large LEO constellations (see below).

Figure 2.12: Global Launch Market Value by Customer 1984-2006*
(source: Euroconsult, 2004)



**2004-2006 are estimates*

Over the ten years from 1994-2003, the commercial launch market was worth $20 billion (i.e., more than 60% of the launch market). The largest single launch market is for commercial GEO satellites, which represent an average of 53% of total annual launches and 55% of the market value ($18 billion), while the non-geostationary commercial launch market was worth 6% of the market value ($2 billion) (Euroconsult, 2004).

Four key players shared this commercial market (market share from 1994-2003)[6]:

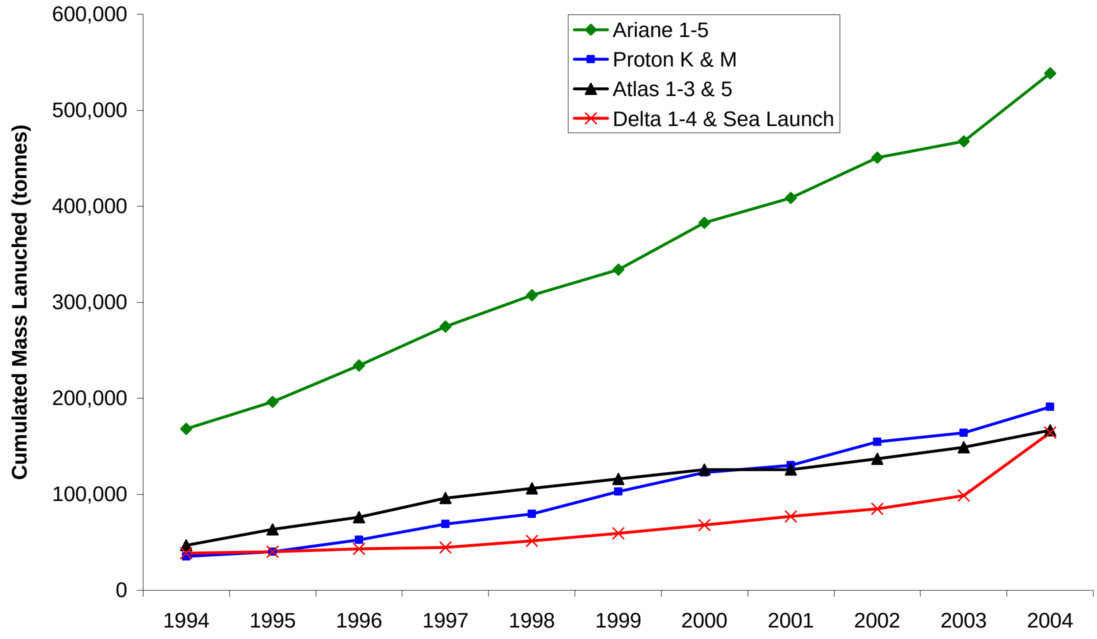
- Arianespace (Ariane 4 (phased out in 2003) and Ariane 5 (first launched in 1999)) (Europe) (46%);
- International Launch Services (ILS (Russia-US) (Atlas II (phased out in 2002), Atlas IIIA, and Atlas V (first launched in 2002) and Proton), controlled by Lockheed Martin[7] (27%);
- Sea Launch (US-Ukraine) and Delta (US), controlled by Boeing Launch Services (13%); and
- Khrunichev (Proton) (Russia) (7%).

Figure 2.13 illustrates the total mass launched by these companies (by vehicle) over the period 1994-2004.

6 It should be noted that the average market share figures mask significant annual variations and that the period 1994-2003 does not reflect the full impact of the change from Ariane 4 to Ariane 5.

7 In 2006, Lockheed Martin exited from ILS and markets the Atlas 5 on its own while ILS markets the Proton.

Figure 2.13: Total Mass Launched per Vehicle for Commercial GEO Satellites (source: Euroconsult, 2004)



This share looks set to continue; as of May 2004, 35% of the $13.7 billion minimum market for commercial launches over 2004-2013 had been firmly contracted, with Arianespace, Boeing and ILS together representing 82% of the orders already placed. A major factor of change during the past decade has been the entry into the international marketplace of Russian and Ukrainian operators, although, as stated above, these are promoted by US companies. Worldwide, several launchers could challenge the three main contenders in the coming years (OECD, 2004), including:

- ISRO (Geo-synchronous Launch Vehicle - GSLV);
- China Great Wall Industry Corp. (Long March) (China); and
- JAXA (H2-A) (Japan).

In addition, it should be noted that a number of smaller players, only launching non-GEO satellites, also exist. As the technology and cost barriers to enter space with small satellites have fallen, the number of participating organisations and countries has risen. Competition and independent national use of space have contributed to an expansion of customers for LEO launch providers (AST & COMSTAC, 2006).

Where possible, institutional customers generally procure satellite systems and launch service from domestic industries, therefore this is a captive market. However, the high sunk investments in land and capital required to establish a launch site is prohibitively expensive for many individual governments, as well as the cost of developing launch vehicles. Consequently, only a limited number of sites exist from which to launch space vehicles. In the military sector, capacity is further constrained by security and procurement issues.

Despite the decline in business in recent years, the supply side has not cut back; new launching capacity has come on stream, leading to significant over-capacity. A new generation of heavy launchers entered the market in the early 2000s, mainly as a response to the trend towards ever larger communications satellites (OECD, 2004). Arianespace was in the red for three years over the 2000-02 period, with a cumulative loss of €538 million ($677 million). However, the company's situation improved in 2003 and it has returned to profitability. In 2005, Arianespace had a turnover of $1,265 million (Space News, 2006a).

2.5 Cost Structure and Competitiveness of the European Launch and Satellite Manufacturing Industry

2.5.1 Cost Structure

In 2005, ASD-Eurospace (2006) indicates that there were 28,000 people employed in the space manufacturing industry, with a consolidated turnover of €4.4 billion. The space manufacturing sector is distributed across Europe, with the main industrial sites located in France, Germany and Italy, and, to a lesser extent, the UK, Spain and Belgium. The concentration ratio of turnover and employment is high within the sector; five large industrial groups (Alcatel, EADS, Finmeccanica, Safran, and Thales) are directly responsible for more than 80% of the total space industry employment.

The industry is highly concentrated across most space sectors; however, this is particularly the case in the hardware sectors, e.g. satellite manufacturing and launch industries. This is because large fixed sunk costs are necessary to develop, test and bring to market various technologies, for example, the Ariane 5 launch vehicle took 10 years to develop at a cost of $9 billion (Space.com, 2000). Such investments, and associated risks and uncertainties preclude many countries from developing domestic space industries and so-called 'national champions' found in similar industries with comparative cost structures (i.e. defence and civil aerospace). Fragmentation is, however, still clearly observed in many parts of the industry, particularly in military space sectors where security concerns are important. This is recognised by ESA (2003) which characterises the equipment and subsystem supplier industry as rather fragmented with a high degree of duplication of competences amongst the equipment suppliers and between the equipment suppliers and the system integrators.

The cost structures are therefore one of the motives for collaboration, cooperation and consolidation within the European space industry as shown by ESA, Arianespace, EADS Space (Astrium) and Alcatel Alenia Space.

However, these cost structures are less prevalent in other sectors. For example, in the case of small nano and micro satellite markets, development costs are significantly lower than those found in the larger satellite and launch vehicle sectors due to less onerous technology requirements and the experimental nature of the spacecraft being developed (which can involve academic institutions). Concentration in these sectors is therefore much lower with many more SMEs inhabiting the market with specialist skills or those transferred from other sectors such as telecommunications. Many subsystem suppliers also fall within this category, including spin-in technologies from related industries.

The number of SMEs in the space sector is rather small, despite the fact that most industrial activities are carried out by small space units. Small dedicated space units are usually fully integrated in larger companies or controlled by larger companies and groups (as above but also Siemens, Sagem, RWE and Fuchs). SMEs represent less than 5% of the total space industry manufacturing employment, whereas small space units (within larger companies) represent around 20% of the total (ASD-Eurospace, 2006). However, it is of note that non-space specific SMEs may be involved as subcontractors to prime contractors.

2.5.2 Competitiveness

The competitiveness of European systems (30-40% European market share on commercial satellites, 33-60% European market share on commercial launchers) contributed to the growth of the European space industry between 1991 and 2001. With the creation of the ESA, European countries were given the opportunity to support a European space policy while at the same time ensuring development of their own industrial space sector (ASD-Eurospace, 2006).

Over the past few decades, European efforts in the field of space have created a solid industrial base and have obtained recognised capability in the field of launchers, science and technology, and applications (in particular telecommunication satellites) (CEC, 2005a). ASD-Eurospace (2006) notes that the core of European space industry businesses (58% in 2005) is related to the design, development and production of satellite systems for operational and experimental services in the areas of telecommunications, Earth observation and navigation. Launcher activities (24%) are a critical domain of activity, followed by scientific activities (14%).

A key challenge for Arianespace and European satellite integrators, as compared to their American competitors, is Europe's much smaller institutional market. As a result of this, Arianespace and the satellite manufacturers depend heavily on commercial success. However, in 2003, ESA and the European Commission indicated that an independent, cost-effective European launcher is in the strategic interests of Europe and must not be threatened by the fluctuations of the commercial market (OECD, 2004).

In 2003, after the decisions made by the ESA Council, the roles and responsibilities of the public and private sector were redefined to achieve a better balance between the two sectors:

- the design, development and manufacture of launchers is carried out by a number of industries throughout Europe. A single industrial prime contractor for each launcher is responsible for the whole process;

- Arianespace, the European space transportation company linked to ESA by a Convention, is in charge of executing the operational launcher exploitation phase, including procurement from the launcher system prime contractor, and the marketing and launch of launchers; and

- ESA is responsible for the overall management of launcher programmes by making the best use of the skills available in the national space organisations of ESA Member States.

ESA report that these measures have streamlined operations, improved transparency and prevented duplication. The European Guaranteed Access to Space (EGAS) Ariane programme will cover some of the fixed production costs for producing Ariane-5 launchers. It has two main objectives:

- to provide Europe with guaranteed access to space by securing the capability to offer reliable launch services for at least six launches a year over a period of five years; and

- to foster the creation of a European institutional market for the Ariane launcher, maximising its use by institutions through competitive market prices, reliable service and launch priority.

Promoting an institutional market within Europe will place Europe on a level playing field when competing with other space industries and ensure the continued production of Ariane launchers. This, in turn, will help guarantee Europe's independent access to space (ESA, 2006).

Despite European efforts to reduce the launcher cost, Arianespace is still disadvantaged vis-à-vis its competitors: for instance, in the cost of an Ariane launch, €10 to €12 million are contributed to launch base operations, whilst for a US civil launch vehicle, where overall range costs are paid by the US Air Force, this contribution is about €1.5 million (EC & ESA, 2001).

ESA (2003) suggests that the European satellite industry is characterised by:

- two independent large system integrators having an overcapacity for system tasks (compared to the present and foreseeable demand) and a high degree of vertical integration;

- a rather fragmented equipment and subsystem supplier industry with a high degree of duplication of competences between the equipment suppliers and between the equipment suppliers and the system integrators; and

- a weak and dispersed added-value industry with ambiguous links with system integrators, in spite of European satellite telecommunication operators being active and successful on the world market.

Whether on the launcher or satellite side, the commercial market will be slow to pick up. Despite some revival of fortunes expected in the next few years, there is no prospect of the commercial market getting back by 2007 to the levels of activity of the late 1990s. It is estimated that the level of activity generated by the commercial market in European industry will correspond to a workload below 50% of the capabilities of industrial production currently available in Europe. This constitutes a challenge for maintaining a balanced European industrial capability, considering that the public space sector will be of increasing importance over the years to come (ESA, 2003).

2.6 Satellite Communication Markets

2.6.1 Main Players

Overview

The satellite communications markets form the largest and most developed downstream sector in the space industry (in terms of turnover). Careless (2005) reports that in 2004, this sector accounted for 63% of space industry revenues. Companies active within the satellite communications markets can be divided in to:

- wholesalers – providing capacity for professional users (e.g. business to business) – these can be further divided into fixed satellite services (FSS) and mobile satellite services (MSS); and
- retailers – providing services direct to the consumers (e.g. business to customer) – these can be further divided into direct-to-home television broadcasting (DBS) and digital audio broadcasting (DAB).

The Fixed Satellite Services (FSS) is the key wholesaler sector, with revenues of $7 billion in 2004 across a global market. However, direct-to-home television broadcasting (DBS) is a much larger market, with revenues of $17 billion, but this is concentrated in the US. These two sectors are discussed below. Other markets, discussed further in Section 2.4.2, are smaller and may be new and emerging, stable niche markets or decreasing markets.

Fixed Satellite Services (FSS)

The FSS industry experienced considerable growth over the years 1990-2000 with annual growth rates over 10% in both revenues and transponder demand. However, due to a stagnant transponder demand combined with decreasing transponder lease prices, revenues declined in recent years but are now recovering; the consolidated revenues of FSS operators increased by 4% in 2004[8] (Euroconsult, 2005b).

Euroconsult (2005b) identifies 36 FSS satellite operators, with a combined turnover of $7 billion. The top four companies represent 60% of this turnover (compared to seven companies ten years ago), whilst the top ten companies account for over 80%. Table 2.7 lists the top ten companies in the FSS industry (in terms of turnover) and

[8] It should be noted, however, that part of the growth in 2004 was generated by currency exchange rates, as six of the top ten operators trade in currencies that continued to strengthen against the US dollar (at 2002 constant exchange rates industry revenues would have increased by 1% in 2004).

their relative market share. This concentration has increased further, with SES Global acquiring New Skies Satellite, and Intelsat completing its merger with PanAmSat in July 2006. It is suggested that the new merged company, which will retain the Intelsat name, is now the world's largest provider of fixed satellite services, with a combined fleet of 51 satellites (Satmagazine.com, 2006). SES Global is now the second largest company.

Table 2.7: Turnover and Market Share of Top 10 FSS Satellite Operators (2004)

Company	2004 Turnover ($ million)	Market Share
SES Global (including SES Astra and SES Americom)	1,433	20.3%
Intelsat	1,044	14.8%
Eutelsat	936e	13.3%
PanAmSat	827	11.7%
JSAT	413	5.9%
Loral Skynet	252	3.6%
New Skies Satellite	243	3.4%
Telesat	224	3.2%
SCC	208e	2.4%
Optus	159	2.3%
Total	**$7.05 billion**	**100%**

Note: e = estimate
Source: Euroconsult (2005b)

Since the mid-1990s, Europe has been the largest market for FSS services, driven by the growth of SES Astra (part of SES Global) and Eutelsat. In 2004, the European industry recorded a turnover of $2.1 billion (+5%), i.e. around 30% of the sector's global turnover. Outside of Europe, Asia-Pacific and North America dominate the world market with markets of $1.7 billion and $1.5 billion respectively, however this excludes the value of DirecTV and Echostar in the US (Euroconsult, 2005b).

The FSS industry is a capital-intensive sector, generating high depreciation and amortization costs, with relatively low costs of sales and operation. During the past three years, the operators have reduced their costs to adapt to the stable or declining revenues generated by the lease of satellite bandwidth. Cost-cutting measures include reductions in workforce and of in-orbit insurance premiums. For example, Intelsat stopped insuring its fleet beyond the first 6-12 months in-orbit, thus saving $10-15 million per year in premium payments (Euroconsult, 2005b).

With company concentration steadily increasing, the sector has enjoyed slow but steady growth over the last few years, with increasing margins (OECD, 2004). The FSS industry has remained a profitable business, even if average profit margins plunged in 2004 to 60% for EBITDA, 21% for operating profit (EBIT), and 16% for net profit. More recent figures, presented in Table 2.8 (overleaf), suggest a more positive outlook for some companies.

Table 2.8: Details of Satellite Operating Companies 2005

Company	EBITDA Margin	Number of Satellites		Comment
		In Orbit	On Order	
Intelsat (incl. PanAmSat)	78%	52	2	-
SES Global (incl. New Skies Satellite)	70%	35	7	-
Eutelsat	77%	22	3	-
Telesat Canada	N/A	6	2	-
JSAT	43.7%	9	3	-
SingTel Optus	34%	5	2	-
Star One	N/A	4	2	SES Global owns 19.99% of company
Space Communications Corp	N/A	4	1	-
Loral Skynet	34%	4	1	Operating Profit
Arabsat	N/A	4	2	-

Source: Space News Top 20 (2006) and Company Annual Reports (2005)

Over the past four years, the average net profit margin has been decreasing from a record 31% in 2000 to 16% in 2004. The number of companies with net losses increased in 2004 and some of these are large companies that were previously positive (Intelsat and PanAmSat). In addition, several smaller operators continued to have net loss in 2004 (APT, Nahuelsat, Satmex) while only the SES Group improved its net profit (+12%) and net profit margin (+3 points) (Euroconsult, 2005b).

Due to a reduction in revenues, FSS operators have undertaken a number of initiatives in recent years to support the development of new business opportunities. While the core business of satellite operators remains strong, operators are targeting several markets with potential over the next ten years, from acquiring service companies to better serve governments with military satellite communications to lobbying and marketing efforts to promote the launch of high definition TV (HDTV) (Euroconsult, 2005b).

In Europe, HDTV is expected to penetrate the mass market significantly by 2008. Leading European pay-TV platforms are already providing HDTV for some programmes. However, significant challenges are facing the market players involved in digital TV, including the standards for HD equipment and the production of content and providing attractive pay-TV offers. Strategic decisions are required to sustain the development of the market and accelerate return on the required short-term investments (Euroconsult, 2005c).

At the same time, strong uncertainties and challenges remain for the industry. Significant competition issues include the continuous growth in submarine and terrestrial cable capabilities, the increasing coverage of mobile networks and the emergence of TV services over digital subscriber lines (DSL) (Euroconsult, 2005b).

Direct-to-home (DTH) Television Broadcasting (DBS)

The DTH industry is the largest segment of the industry with revenues of $17 billion, but it is concentrated in the US. These companies are vertically integrated and are able to take full advantage of the technological progress achieved upstream in satellite manufacturing and downstream in digital compression. This means that they are able to compete effectively with cable operators despite high barriers to entry in the TV subscription market (OECD, 2004). Growth has been extremely rapid, and its success is mostly due to considerable progress in the productivity of DTH satellites over the last decade. The distribution capacity of video content for satellite has been multiplied by 187 in ten years. At the same time, the number of channels that can be distributed by each transponder has increased twelve-fold (OECD, 2004). There are only two players in this market, as illustrated in Table 2.9.

Table 2.9: Turnover and Market Share of US Direct Broadcasting Satellite Service Providers		
	2004 Turnover ($ million)	**Market Share**
DirecTV Inc	9,764	57.7%
Echostar	7,151	42.3%
Total DBS	**$16.9 billion**	**100%**
Source: Euroconsult (200b5)		

2.6.2 Niche Markets

Two types of niche markets can be identified - where a niche market is defined by its turnover in relation to the overall market size - as follows:

- niche markets which are relatively stable; and
- new markets which are expected to grow in the coming years.

Stable Markets

The revenue of the mobile satellite services (MSS) industry reached $1 billion in 2004, and it has seven key players, as illustrated in Table 2.10. However, industry growth slowed down in 2004 (+7%) after two exceptional years in 2002 and 2003 (+30%) that were boosted by Inmarsat's growth and the beginning of activity of Thuraya. Both operators benefited from the strong growth in demand originating from Afghanistan and Iraq in relation to the military operations in these countries. As the military activity in these countries had subsided in 2004, the MSS industry slowed down. Demand for mobile satellite communications service continued to be driven by military operations and aid areas in 2004 (Euroconsult, 2005b).

Table 2.10: Turnover and Market Share of Mobile Satellite Service Providers (MSS)		
Company	**2004 Turnover ($ million)**	**Market Share**
Inmarsat	473.8	44.3%
Thuraya	322 e	30.1%
Iridium	98.5	9.2%
Globalstar	70	6.5%
ACeS	50 e	4.7%
MSV	35	3.3%
Orbcomm	20e	1.9%
Total MSS	**$1.1 billion**	**100%**
Source: Euroconsult (2005b)		

The utility of mobile satellite communications was demonstrated after hurricane Katrina struck areas of the US Gulf Coast in 2005. Traditional land-based communications systems were shut down for days or weeks, creating an opening for MSS. Iridium and Globalstar activated an estimated 20,000 handheld satellite phones in the area soon after Katrina hit in an attempt to meet high demand. To date, it is unclear whether the vulnerability of cellular and other land-based communications will translate into significant increased business for Iridium and Globalstar as primary or back-up communications for emergency services and other disaster response users. In the meantime, Iridium, Globalstar and ORBCOMM, have been successful in garnering new investors and rolling out new services (AST & COMSTAC, 2006).

Growing Markets

The key markets falling under this category are digital audio broadcasting (DAB) and digital multimedia broadcasting (DMB). DAB satellite services are available in North America and DMB satellite services have been launched in Japan and Korea in 2005 (Euroconsult, 2005b). DAB may currently be considered a niche market based on its turnover ($320 million in 2004), but it is likely that the market will grow significantly; it is expected to mirror the growth of satellite television in the 1990s. The DAB market is currently dominated by two main companies, as shown in Table 2.11.

Table 2.11: Turnover and Market Share of Digital Audio Broadcasting by Satellite (S-DAB) Operators

Company	2004 Turnover ($ million)	Market Share
XM Satellite Radio	244	76.4%
Sirius Radio	66.8	20.9%
Worldspace	8.5	2.7%
Total DARS	**319.5**	**100%**

Source: Euroconsult (2005b)

Satellite radio is already among the fastest adopted consumer electronics products in US history. However, neither Sirius Satellite Radio nor XM Satellite Radio are currently profitable, primarily because of increased marketing and programming costs, although both anticipate reaching cash-flow breakeven by the end of 2006 (AST & COMSTAC, 2006).

While the DAB market has been limited to North America to date, there is growing interest in satellite radio systems elsewhere, principally in Europe. WorldSpace, which currently operates two GEO satellites with listeners in Europe, Africa, Asia and the Middle East, is planning to launch a third GEO satellite to serve Europe. Ondas Media, a Spanish company, and Europa Max, based in Luxembourg, are each planning systems modelled on Sirius, with three satellites in HEO. Both ventures are in the process of raising funds and have yet to announce satellite and launch contracts for their systems (AST & COMSTAC, 2006).

2.6.3 Transponders Availability and Lease Prices

Euroconsult (2005b) indicates that global transponder demand increased by around 2.8% in 2004 (up from 1.7% in 2003 and a negative growth of 0.5% in 2002). The number of transponders leased is also estimated to have increased from around 4,100 units in 2000 to around 4,400 units in 2004. North America (1,182 units), Asia Pacific (1,037 units) and Western Europe (730 units) accounted for around 70% of transponder demand in 2004. This represents a 1.5% compound annual growth rate (CAGR) over the period which, when compared to a 10% CAGR in the mid-nineties, highlights the maturing of the business.

Transponders can be used in four key applications:

- video broadcasting (of TV channels);
- video contribution;
- direct to user (DTU) satcom services (where these include corporate networks, internet protocol (IP) access and government, civilian and military communications); and
- traffic trunking (IP & non-IP).

Globally, video broadcasting continues to dominate the market with 54% of total transponder demand (and a growth rate of 4.7%) in 2004 - the broadcasting of analogue, digital standard definition and HDTV channels alone accounting for 39% of total usage. In North America and Western Europe, video channel broadcasting represented 52% and 47% of total transponder usage respectively. If video contribution is added, around 70% of satellite leases in Western Europe are used for video-related services. For comparative purposes, around 60% of total transponder usage in Asia Pacific (the world's second largest transponder market) is dominated by voice and data traffic. Unlike the rest of the world (where the C-band dominates), the Ku-band is the most dominant in Europe, accounting for 81% of the transponder market in Western Europe (Euroconsult, 2005b).

In 2004, global transponder demand increased by almost 3%, while the number of transponders commercially available in orbit increased by around 5%. After a continuous growth period between 1997 and 2000, the average fill rate has been decreasing for the past four years - slipping down to 64% in 2004. The fill rate in Western Europe - which is the second region in terms of transponder loading - was estimated at 68% in 2004. Historically, Western Europe has maintained a high fill rate as the market is dominated by SES and Eutelsat who carefully manage the demand/supply balance to avoid over-capacity. In 2004, the fill rate for Western Europe decreased by three points as a result of growing transponder supply (+4.5%) not matched by demand which grew by 0.4%. Overall, transponder supply has increased at a CAGR of 2.5% making it the region with the lowest average growth rate behind Latin America over the same period. This slow growth was partly the result of two failed satellite launches (which were supposed to provide 90 transponders) in 2002 (Euroconsult, 2005b).

In 2004, Western Europe represented 17% of the world transponder demand, generating 28% of revenues for FSS operations that year with more that $2 billion. Western Europe has historically maintained higher transponder prices than other markets mainly because it is the home market of two of the world's largest operators. While a large part of customers pay leasing fees in Euro, most of the CAPEX of European satellite operators are negotiated in dollars with the satellite manufacturers and launch service providers. European operators have thus benefited from the increase of value of the Euro versus the dollar in the last two years.

Transponder prices are negotiated on a case-by-case basis with lease fees spread over several years, depending on the duration of the contract. Several factors impact on price in the FSS industry, of which transponder frequency band and power, backup, duration and volume of the lease are the main ones. Other operator specific factors come into play where these include:

- unique beam or transponder interconnectivity scheme;
- exclusive coverage/power level;
- teleport service;
- backhaul service; and
- video neighbourhood.

These factors play an important role in differentiating satellite bandwidth from a commodity and highlight the ability of satellites to provide services that could either not exist without satellites or would not be cost-effectively provided by alternative terrestrial solutions (Euroconsult, 2005b).

Since 1998, the average revenue derived per year from a 36MHz transponder has been decreasing. This decrease was stopped in 2000 (by one-off events) and between 2000 and 2002, the average revenue per transponder decreased at a CAGR of 3.6% - to a world average of $1.66 million per year. In general, the average revenue per transponder varied from region to region - ranging from $0.89 million to $2.9 million in 2004 across various world regions. Western Europe generated a higher average revenue per transponder than any other region - the quasi-duopoly for satellite TV broadcasting being a major influence. In 2004, the average revenue per transponder grew by an estimated 3.6% to $2.9 million. Most of this growth has been generated by the continuous decrease of the US dollar exchange rate (vs. the Euro) in 2004 - apart from which the prices have been relatively stable over the last five years (Euroconsult, 2005b).

In the short-term, growth in Western Europe will be driven by broadcasting applications, particularly the increase in digital standard definition services offered to customers. In the medium-term, there is still a growth potential in transponder demand, primarily driven by direct to user services, including video broadcasting and direct to users satcom services (corporate networks, military and civilian government communication and Internet access). While and if video broadcasting should remain the primary market for satellite operators globally, voice and data traffic remains important for the industry with 46.5% of the transponder demand planned by 2014.

Euroconsult (2005b) estimates that transponder demand in Western Europe will grow at a modest pace over the next ten years, with an expected CAGR of 0.7%. From 730 transponders in 2004, transponder demand is likely to stand at around 780 units leased by 2014. Western Europe is expected to remain the third region in terms of transponder usage behind North America and Asia.

2.7 Other Satellite Applications Markets

2.7.1 Earth Observation

Earth observation (EO) was one of the earliest applications of satellites; however, commercial observation satellites are still relatively new. The industry started when restrictions on satellite imagery technologies were relaxed at the end of the cold war; however, it has not grown as rapidly as expected (OECD, 2004). Key players include:

- DigitalGlobe (US);
- GeoEye (formed as a result of the ORBIMAGE acquisition of Space Imaging in January 2006) (US);
- Spot Image (a subsidiary of EADS Astrium) (Europe);
- ImageSat International (Netherlands Antilles);
- InfoTerra Global (a subsidiary of EADS Astrium) (Europe); and
- MDA Geospatial Services (Canada).

Over the past few decades, satellite Earth observation technology has proved to be an increasingly powerful tool to monitor and assess the Earth's surface and its atmosphere on a regular basis. Earth observation satellites allow efficient, reliable and affordable monitoring of the environment over time at global, regional and local scale. This makes satellite-based Earth observation a fundamental input for geographic information systems (GIS) on numerous and diverse issues. These include military uses (Euroconsult, 2004).

Commercial satellite remote sensing is one small part of a much larger industry that creates products based on geospatial information. The greater industry for remote sensing and GIS consists of maps and databases linking geographic data with demographic or other economic information, or scientific data. The other major sectors of the industry include aerial imaging, ground stations for data collection and processing, and value-added systems that include GIS and other analytical tools that prepare image and map products for end-users (AST & COMSTAC, 2006).

The commercial market for satellite-based high-resolution imagery has grown more slowly than expected several years ago, limiting the anticipated demand for new commercial remote sensing satellites. Growth has been hampered by competition from aerial photography and land-based surveys using global navigation satellite systems (GNSS) and geographic information systems (GIS) that both compete with and complement commercial observation satellite imagery. In addition, international competition is likely to be fierce as new low-cost players enter the market (OECD, 2004). As a result, remote sensing satellite companies have become increasingly dependent on government business to maintain their competitive edge. Although commercial remote sensing faces competition from civil, military, and intelligence imaging systems, the ever increasing worldwide government demand for high resolution imagery has opened a major market for remote sensing companies (AST & COMSTAC, 2006).

There are current and future applications that could provide increased demand, including low and medium resolution imagery for civil and commercial activities in scientific studies (forestry, geology, coastal change), agriculture, disaster response, homeland security, and other applications (AST & COMSTAC, 2006).

Figure 2.14 indicates the turnover of the European space industry associated with Earth observation; similar data are not available at the global level.

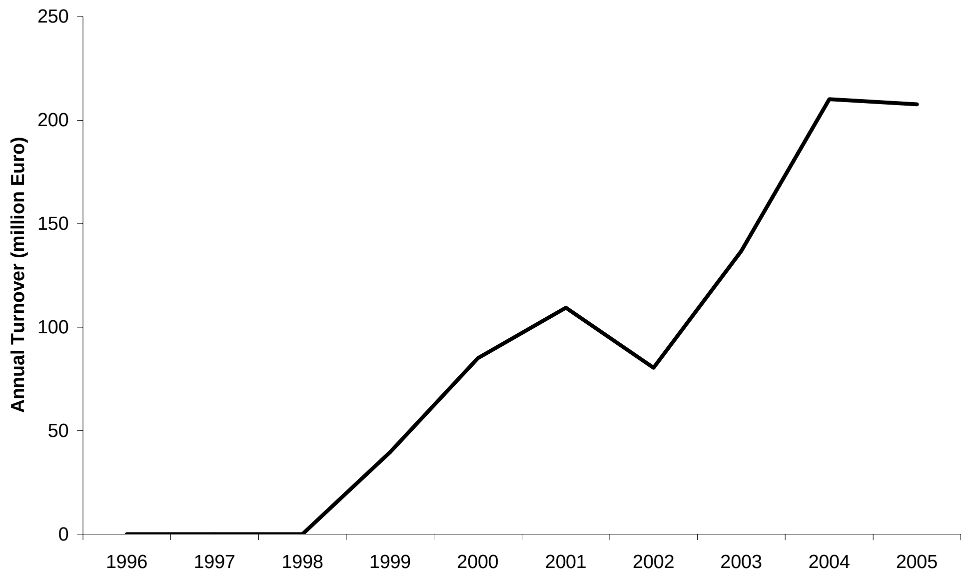
Figure 2.14: European Space Industry Turnover Associated with Earth Observation 1996-2005
(source: ASD-Eurospace, 2006)

2.7.2 Navigation/Localisation

The use of satellites for location and navigation purposes, and the associated downstream services and markets, is a rapidly expanding market, although only one system, the US Global Positioning System (GPS), is currently fully operational. It remains under military control but is also available to commercial users free of charge; GPS has already created a substantial downstream market estimated at about \$10.6 billion in 2001 (this includes both the hardware and value-added services). By 2010, this market could quadruple to \$41 billion as GPS chips are integrated in a growing number of products (OECD, 2004).

As the use of the US GPS becomes ubiquitous and as more systems depend on it, there is growing concern that a disruption in the signal could have significant consequences worldwide. This has played an important role in inducing non-US space-faring countries to launch their own global positioning and navigation systems. In particular, the European Galileo system is expected to complement and compete with GPS – in civil and military markets (OECD, 2004). This is a relatively new area of development for the space industry in Europe. Fuelled by Galileo development programmes, this area should significantly grow when the Galileo system rollout begins (ASD-Eurospace, 2006). Figure 2.15 illustrates the European space industry turnover associated with navigation, which has increased substantially in recent years as a result of investment in Galileo.

Figure 2.15: European Space Industry Turnover Associated with Navigation 1996-2005
(source: ASD-Eurospace, 2006)



3. REGULATORY ISSUES FOR THE EUROPEAN SPACE INDUSTRY

3.1 Overview

Regulations and policies that may affect the space industry can be implemented at international, regional (e.g. European), and/or national levels. Similarly, space legislation can apply to different sectors of the industry from launch activities and satellite manufacturing to operation and downstream uses of the space infrastructure.

The Study Team identified the following regulatory priorities for industry:

- dual-use export controls and inconsistencies amongst EU Member States, as most prominently associated with EC Regulation 1334/2000 and ITAR;
- frequency spectrum and orbital slot allocations by the International Telecommunication Union (ITU);
- the role of the World Trade Organisation (WTO) in relation to services - this is important to ensure global access to satellite networks;
- liability issues relating to debris in space, as increasingly complicated by launches at sea in international waters, which makes it difficult to assign responsibility;
- progress on the EU Internal Market following the Satellite Directive is not complete, wherefore further measures could be adopted to improve competition; and
- global standards for components and services – where some may occur through industry cooperation where technical advantages exist, yet others in relation to ‘public interest’ are required, for example in relation to ensuring consumers have access to satellite services and are not discriminated against.

Consultation to discuss these issues (and any other matters arising) was undertaken with a range of stakeholders. Twenty stakeholders were contacted by email, of which one declined and seven provided telephone or face-to-face interviews. Follow-up emails were sent to those that had not responded to the initial contact. Of those providing interviews, three represented industry (large and small companies), two represented national government organisations and two were independent. Additional feedback from industry on regulatory issues has been provided by the Commission, covering a further five organisations, with follow-up consultation by RPA.

3.2 Dual-use Export Controls

3.2.1 Overview

Dual-use items are goods and technology developed for civilian uses, but which can be used for military applications. In the context of dual-use export controls (and potential issues for European industry) the two single most important legislative items are the EC Regulation 1334/2000[9], as recently updated by EC Regulation 394/2006[10], and the US International Trade in Arms Regulations (ITAR) which affect the opportunities for the European industry to export space-related hardware, software and even services.

3.2.2 EC Regulation 1334/2000

Within Europe, the issue of political risks arising from potential exports of dual-use items has been addressed by EC Regulation 1334/2000, which sets up a regime for the control of exports of dual-use items and technology from the EU Member States[11]. CEC (2006a) notes that although the Regulation is applicable throughout the EU, its implementation relies on the national administrations of Member States, which have a relatively high degree of flexibility, especially regarding the possibility of introducing additional national controls.

An authorisation is required to export the dual-use items listed in Annex I (which is essentially similar to the Wassenaar Arrangement's[12] List of Dual-Use Goods and Technologies). If the prospective exporter is aware that an item, even if it is not listed in Annex I, might be used in a way proscribed by the Regulation, it is still bound to apply the applicable provisions[13]. Under the Regulation, export is defined to include transmission of software or technology by electronic media, fax or telephone to a destination outside the Union.

The Regulation establishes a Community General Export Authorisation (CGEA) as set out in Annex II for certain exports. Annex II, Part 1, specifies that the CGEA is possible for all dual-use items listed in Annex I, except those specified in Annex II, Part 2, dealing with the more security-sensitive items. National export authorities are not automatically obliged to provide a CGEA, however, and, in any event, the exporter must comply with certain reporting requirements, as set out in Annex II, Part 3.

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9 **Council Regulation setting up a Community regime for the control of exports of dual-use items and technology**, No. 1334/2000/EC, of 22 June 2000; OJ L 159/1 (2000).

10 **Council Regulation amending and updating Regulation (EC) No 1334/2000 setting up a Community regime for the control of exports of dual-use items and technology**, No. 394/2006/EC, of 27 February 2006; OJ L 74/1 (2006).

11 EC Regulation 1334/2000 has been amended and updated by Council Regulation amending Regulation (EC) No. 1334/2000 with regard to intra-Community transfers and exports of dual-use items and technology, No. 2889/2000/EC, of 22 December 2000; OJ L 336/14 (2000); Council Regulation amending Regulation (EC) No. 1334/2000 with regard to the list of controlled dual-use items and technology when exported, No. 458/2001/EC, of 6 March 2001; OJ L 65/19 (2001); and Council Regulation amending and updating Regulation (EC) No. 1334/2000 setting up a Community regime for the control of exports of dual-use items and technology, No. 2432/2001/EC, of 20 November 2001; OJ L 338/1 (2001). The very last amendment was, of course, by means of EC Regulation 394/2006.

12 The Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies, Wassenaar, agreed 19 December 1995, effective 12 July 1996, provided for a global, formally non-binding arrangement on export controls for conventional weapons and sensitive dual-use goods and technologies.

13 See Art. 4, EC Regulation 1334/2000.

For all other items, authorisation shall be granted by the Member State where the exporter is located[14]. This authorisation may be an individual, global or general authorisation. Member States must maintain or introduce in national legislation the possibility of granting a global authorisation to a specific exporter for dual-use items valid for export to one or more specified countries. The competent authorities may refuse to grant an export authorisation and may annul, suspend, modify or revoke an export authorisation which they have already granted[15]. Exporters are required to keep detailed records of their exports.

Whilst stakeholders acknowledge the need for export controls, most consultees consider there to be problems with the practical implementation of the Regulation by Member States. Consultation with industry suggests that the large measure of discretion remaining with the individual states as to the actual granting of licenses may constitute a major obstacle for European industry to achieve economies of scale and/or scope required with a view to the global markets. The differences can range from the interpretation of intangible transfers of technology and inclusion of different technologies by Member States, to the time taken to grant the licences. RPA (2006) notes that the barrier to trade is often not that applications for licences are refused, but that the time taken to issue a permit can vary between a couple of days and several months. However, in some countries, this process is predictable and companies are able to factor in the time required for clearance.

The uncertainty surrounding such a process and the administrative burden of shipping many different components at a time can therefore present a significant barrier to trade. The impact of these differences, and thus the difficulties incurred by industry, may add resource costs to the development and production processes and, in the worst case, can prevent companies for bidding for contracts, thus affecting their competitive position.

One solution suggested by a number of consultees would be to harmonise export controls at the EU level, with an EU standard for export control. This would be beneficial to industry, particularly multi-national companies. However, it is considered that this would require clear priorities regarding what technologies should be protected, from whom and why; this is considered to missing at present. Only once there is an agreed policy can the Commission negotiate export controls more clearly. Some consultees identified that sufficient technical competence was essential for negotiating on export controls associated with critical technologies and their applications

Another consultee considered that there was no role for the Commission on this issue and that it is a national issue for Member Sates to address. It was also noted that EU level control may cause problems since EU standards may be set at a relatively low standard (in order to achieve a consensus) and this may jeopardise the intellectual property rights of technical players. Thus, it is recognised by consultees that managing export controls at the EU level could cause problems. Therefore,

14 See Art. 6, EC Regulation 1334/2000.

15 See Art. 9, EC Regulation 1334/2000.

consultees would welcome Commission guidelines/framework, but pragmatically this would not subsume national controls.

In general, consultation suggests that there is little coherence between export policies in Europe, and consultees consider that this should be improved with better coordination, whilst recognising that control should be kept at the national level due to military concerns.

These views are supported by the findings of IMS (2006), which are based on consultation with 156 companies[16] with experience of export controls across Europe. IMS (2006) highlights the following issues associated with the current EU regime on export controls of dual-use goods and technologies:

- **interpretation of the Annex I list** - many exporters said that they had difficulty in understanding and interpreting the dual-use list;
- **inconsistent Technical Assessments by Licensing Authorities** - it was reported during the study that some Member States are making certain goods licensable under Annex I while other Member States are not;
- **treatment of multinational companies regarding intangible technology transfers** - the issue raised was that governments needed to understand that research and development were carried out by multinationals on a global scale, between several research labs and even with third parties. It was remarked that it is "fiction" to believe authorisations would be applied for in each exchange of technology and that multinational companies should be viewed as one entity, rather than separate companies in the Member States in which they operate;
- **inconsistent licensing policies across the EU -** one company remarked that as they had to apply for authorisations in multiple Member States to export the same products to the same destinations, they sometimes re-routed the goods within the EU to make use of available authorisations in other Member States;
- **application and processing times** - many exporters expressed their concerns and frustrations about the differing procedures and processes Member States employ to approve authorisations, particularly the length of time obtaining an authorisation currently takes. They believed that this impacted on their competitiveness and led to a distortion in trade. Others referred to the difficulties they had in clarifying the processes and supporting information each Member State required for authorisations; and
- **comparisons with other export controls** - as part of the questionnaire, companies were asked for their experience of global export control procedures. Overall, companies judged the EU system as comparable to those in Australia, Canada, Japan, and, in most areas, better than those in China, Russia and the United States. Many companies who had experience of the US system commented about the complexity of US administrative practises and legislation.

On 18 December 2006 (during the period of consultation for this Study), the Commission published a *Communication on the Review of the EC Regime of Controls*

16 It is not known how many space-related companies are included within this number.

of Exports of Dual-use Items and Technology (CEC, 2006a). This presents a proposal for a recast of Regulation 1334/2000, together with a number of proposals for non-legislative action. These proposals have three objectives:

- to improve security by making export controls more effective, in the context of an enlarged European Union of 27 Member States;
- to provide a more friendly regulatory environment for business in order to promote their international competitiveness, by introducing more clarity in the EU export control regime, reducing regulatory burdens in the implementation of controls by EU exporters, ensuring a more consistent and homogenous application of the EU export control regulation across the EU, and facilitating trade within the internal market; and
- to promote greater coordination of export control at international level.

To this end, the following proposals, *inter alia*, are made, which would address the concerns of industry expressed through consultation:

- improving the exchanges of information among Member States and with the different parts of their Administrations;
- improving the cooperation among Member States regarding the application of national controls on non-listed items;
- clarification of certain provisions of the Regulation, such as regarding intangible transfers of technology, which are currently applied in a different way by Member States;
- promotion of the use of global licences based on greater reliance on internal controls applied by enterprises, and greater recourse to Community and national general export authorisations;
- provision for the establishment by Member States of indicative deadlines for the handling of applications for export authorisation;
- adoption of guidelines or best practices for the implementation of the Regulation, in order to achieve greater consistency in its application by Member States;
- closer coordination of EU positions in the international export control regimes;
- a better involvement of EU industry for the determination of items to be subject to controls;
- a provision establishing the possibility of adopting ad-hoc export control procedures for EU research programmes and other projects where third countries are involved; and
- the introduction of a regulatory committee for the introduction of amendments to the annexes of the Regulation, which contain the lists of controlled items and other technical provisions. This procedure would enable a quicker update of the list of controlled items, which at present requires a Council decision on the basis of a Commission proposal.

These proposals have been subjected to an Impact Assessment (see CEC, 2006a), and are presented to the Council for examination. In principle, the proposals appear to address the key concerns of industry identified through consultation, however, the final revisions and their implementation in practice will be significant for improving the competitiveness of the European space industry.

3.2.3 International Trade in Armaments Regulations (ITAR)

The International Trade in Armaments Regulations (ITAR) are the main tool applied by the US government to control the transfer of defence related articles, including technical data (which can often be more valuable to the importing country as it can provide the knowledge and specifications required to replicate a specific technology).

The ITAR make it mandatory for defence products and technical data to carry an export licence if listed on the United States Munitions List (USML), which defines all products and services under 21 different categories. If an item is listed, then it requires a licence, issued by the Department of Defense, through the joint decision making of many government agencies, including the State Department and the Commerce Department. Consistent with the rules on procurement, Congress is also involved, as it can veto any waiver or control imposed by either department.

The State Department is considered to have adopted a protectionist approach to US interests and is argued by many to have increasingly used export licences as a tool in foreign policy (PMDTC, 2006). Export controls have therefore been maintained in a tough stance even when the Department of Defense (DoD) wishes the rules to be relaxed to allow US manufacturers access to cheaper imports of non-security sensitive equipment. It has also hindered the DoD and Commerce Department in revising the USML by removing products and technical data which are obsolete or no longer poses a threat to national security (and constrain the export opportunities available to many US companies) (Ashbourne, 2000).

It is important to highlight the fact that ITAR measures have proved to be a significant disadvantage to US businesses, particular with regards dual-use goods and services indicated in the USML. For example, without ITAR approval, US satellite manufacturers are unable to discuss technical performance details with the customer, obtain insurance for a satellite (most insurers for spacecraft are in London), export a satellite to a launch site or assist ground operators with flying instructions. Due to the size and cost of launch vehicles and other spacecraft, Congressional approval is also required, extending the time it takes ITAR to be approved.

Consequently, European manufacturers have been quick to offer ‘ITAR-free’ products and services, consequently gaining significant market share in recent years; this has made the European industry the market leaders in this area, with the opportunities for ITAR-free satellites benefiting the European industry. A recent report by the International Space Business Council (ISBC, 2005) cites US export regulations under ITAR as ‘what were initially a nuisance to businesses have evolved into a serious problem for US industry’. It is described as ‘the industry’s most serious issue’. Overall, such developments have created a barrier to exports by US manufacturers.

The Memorandum of Understanding between the US and some EU Member States does provide some dispensation for the European defence industry, as under such agreements export-licensing procedures are waived, reducing these direct barriers to trade in many defence related areas. However, this can cause problems within the EU if only certain Member States are given this preferential treatment, resulting in unnecessary friction between allies in terms of trade and access to the technologies involved.

Extending this analysis to US R&D, which is often carried out in academic institutions and located within a technology cluster close to industry, ITAR have restricted non-US nations from access to many research areas. In many cases, research is carried out in a commercial environment and defence is inseparable from civil work. By restricting access, the ability and efficiency by which innovations and advancements in technology are made can therefore be affected

Given the above, it is therefore unclear whether ITAR is a benefit or disadvantage to Europe overall, and this range of views is supported by consultation with stakeholders. ESTP (2006) notes that on every European satellite, a significant share of components and equipment are procured outside Europe, primarily from the US, and these are used in all spacecraft subsystems, platforms, as well as institutional and commercial payloads. Whilst some companies have benefited from producing ITAR-free equipment, this can be very expensive. Other stakeholders indicated that they had stopped trading with US companies due to the difficulties encountered with ITAR, although it is noted that this can be problematic and depends on the equipment required. As for European export controls, one of the key problems for those companies wishing to trade with the US are the delays in the procedures handled by the US Administration; ESTP (2006) notes that such delays can be costly. There is a strong suggestion that the European Commission should seek to simplify and streamline the administrative procedures which have become a source of uncertainty and delays for European manufacturers. Large European companies have established departments within their procurement divisions to deal with ITAR related goods, which has increased their costs. However, there is some concern from companies that have developed methods of dealing with ITAR that any intervention by the Commission may upset the equilibrium achieved. However, despite these issues, consultees did not report that they had been prevented from purchasing equipment (where this assumed to relate to equipment for European use). However, companies have noted difficulties associated with equipment for export to third countries.

An alternative way forward is for Europe to develop independent technology. Current coordination efforts are managed by the European Space Components Coordination, which was established in 2002. In 2004, the European Components Initiative (ECI) was launched to fill the strategic gaps in the availability of European electrical, electronic and electromechanical (EEE) components suitable for use in space. The ultimate objective of the initiative is to substantially reduce (if not eliminate) the dependence of European space programmes on non-European sources for EEE components, particularly those that might be subject to US export restrictions (ESTP, 2006). Therefore, ESTP (2006) suggests the following actions are needed:

- continue the ECI beyond the current emergency action, based on a sound long term basis;
- start new initiatives aimed at securing availability of other basic components and subassemblies that might be subject to US export restrictions; and

- support the creation of a supplier base for advanced but currently immature technologies.

One consultee questioned whether it was worthwhile for Europe to become self-sufficient, considering the additional investment required, and suggested that it may damage transatlantic relations (where space components are a small part of the dual-use/defence markets). Others considered that European autonomy could only benefit industry, but noted that there were a number of specialist components that it would difficult for European companies to manufacture and compete with the US, as US companies were particularly advanced in some fields. It was also suggested that the current scale and structure of European funding would not be sufficient to establish an autonomous component market. Another consultee suggested that US policy was changing, with a lifting of restrictions making it easier to export from the US. Therefore, the benefits of ITAR experienced by European companies, and the advantages of developing European autonomy in components, are disappearing, and competition from the US is increasing. Therefore, although some stakeholders doubted the current (institutional) ability, and justification for increasing European independence in the supply of components, industry and institutional stakeholders generally supported such efforts.

3.3 The International Telecommunication Union (ITU) Regime

Any space activity requires the usage of the radio spectrum in order to allow constant control of, and communication with, the spacecraft involved. In addition, the use of satellites for telecommunication purposes (i.e. broadcasting, voice and data transfer, etc.) is the largest commercial sector of the space industry. For these reasons, the way in which international access to the radio spectrum is regulated represents a key enabling factor for the European space industry – in particular the service and applications-oriented industry.

The International Telecommunication Union (ITU)[17] represents the global forum *par excellence* for dealing with the allocation of frequencies used for telecommunication activities, including the use of radio-wave frequencies for any communication with satellites or other spacecraft, and, almost by inference, the allocation of orbital slots (as far as the geostationary orbit is concerned) and orbits (as far as other orbits are concerned). This aims to avoid harmful interference with any officially acknowledged international use of the radio spectrum and maximise the efficient, transparent and fair use of that radio spectrum, as well as (in the case of space activities) the orbital slots or orbits involved.

[17] Established in its current version by means of the Constitution of the International Telecommunication Union (hereafter ITU Constitution), Geneva, done 22 December 1992, entered into force 1 July 1994; 1825 UNTS 1; UKTS 1996 No. 24; Cm. 2539; ATS 1994 No. 28; Final Acts of the Additional Plenipotentiary Conference, Geneva, 1992 (1993), at 1; and the Convention of the International Telecommunication Union (hereafter ITU Convention), Geneva, done 22 December 1992, entered into force 1 July 1994; 1825 UNTS 1; UKTS 1996 No. 24; Cm. 2539; ATS 1994 No. 28; Final Acts of the Additional Plenipotentiary Conference, Geneva, 1992 (1993), at 71.

Despite some efforts to provide non-state entities (both intergovernmental organisations and private operators) a larger say in the development of the ITU legal regime, the ITU is still a classic intergovernmental organisation dominated, legally speaking, by states[18]. This is certainly also true when it comes to the complicated process of trying to coordinate and regulate the use of radio frequencies as well as, in the case of satellite operations, geostationary orbital slots or non-geostationary orbits[19].

In short, this process could be characterised as a two-step, or three-step, approach. Actual decisions regarding the use of frequency spectrum are firstly taken at World (Administrative) Radio Conferences with reference to generic types of services – the 'allocation' of frequency bands[20]. 'Allocation' is defined as designating a frequency band "for the purpose of its use by one or more terrestrial or space radio communication services or the radio astronomy service under specified conditions"[21].

Secondly, states may then apply for use of specific frequencies and attendant slots or orbits for a satellite project (or other space activity). After a procedure of 'advanced publication', i.e. the filing of a proposal for a satellite system and extended coordination with affected operators, 'allotment' takes place of the frequencies and attendant slots or orbits. 'Allotment' is defined as the "entry of a designated frequency channel in an agreed plan, (…) for use by one or more Administrations for a terrestrial or space communication service in one or more (…) countries or (…) areas"[22]. "Administrations" in this context unambiguously refers to states[23]. Allotment of frequencies to a specific Administration for a specific proposed satellite system then leads to inclusion in the Master Register, guaranteeing to the intended user, in theory at least, interference-free usage of those frequencies.

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18 Relevant efforts resulted at the Kyoto Conference of 1994 in an amendment to Art. 19, ITU Convention, allowing for the participation of non-governmental entities as 'small-m' members, providing them with the right of access to all relevant information as well as consultation; and at the Minneapolis Plenipotentiary Conference of 1998 in allowing them to achieve a status of 'Sector members', i.e. of full-blown participation at the ITU sector level. Yet, states are still the only full members of the organisation represented on the Council; see e.g. Artt. 2, 4; also Artt. 3, 8, 10, ITU Constitution.

19 It should be noted that formally, for a long time, the ITU had competence only to coordinate the use of radio frequencies; since it however soon became apparent that the risk of actual interference (a main aim for ITU to try and prevent or minimise) depended also on the geographical location of the satellites at issue, ITU effectively started taking those positions into consideration as well, first only for the geostationary orbit (as the main orbit of interest for a long time), then for other orbits as they became populated as well. This was ultimately reflected in Art. 44, ITU Constitution, listing radio frequencies, the geostationary and other orbits equally as limited natural resources calling for a use which should be rational, equitable, efficient and economic – with the ITU regime being tasked to realise such aims.

20 See Art. 13, ITU Constitution; Art. 7, also Art. 9, ITU Convention.

21 Section 1.16, Radio Regulations.

22 Section 1.17, Radio Regulations.

23 See Annex to the ITU Constitution, first bullet: "Administration: Any governmental department or service responsible for discharging the obligations undertaken in the Constitution of the International Telecommunication Union, in the Convention of the International Telecommunication Union and in the Administrative Regulations".

If it is the state itself which will operate the satellite system, the process stops here, after two steps. If, however, the process concerns a satellite system to be operated by a non-state operator, whether this concerns an intergovernmental organization or a private operator, a third step is necessary: that of ‘assignment’. The state is allotted the use and coordination of frequencies and slots or orbits, which, in turn, it ‘assigns’ to the intergovernmental organisation or private operator concerned. ‘Assignment’ of a radio frequency or radio frequency channel is defined as the “authorization given by an Administration for a radio station to use a radio frequency or by an Administration for a radio station to use a radio frequency or radio frequency channel under specified conditions”[24].

Consultees note that satellite services - which generally provide pan-European services - require the agreement of numerous administrations before it is possible to proceed with a pan-European satellite project. If some countries choose to interpret Conférence Européenne des Postes et Télécommunications (CEPT) Decisions in a manner that could adversely affect operations of a pan-European satellite system, then the satellite operator(s) would have to bear extra costs and resources to find a manner to work around any problems encountered within certain countries. However, the extent to which this may occur is not clear.

A further issue is the competition between terrestrial operators and satellite manufacturers. The difference in timescales (between terrestrial and satellite systems) from R&D to operation, and the different requirements for disclosure of intentions results in an imbalance in network procedures. It is suggested by consultees that the satellite industry would be in a better position if information about utilisation of spectrum by terrestrial systems were to be made available with the same level of detailed technical information which is required for satellite systems.

An example of the competition between terrestrial and satellite operators is presented by Oberst (2007). Oberst (2007) notes that some satellite operators are concerned that national preoccupations with finding more spectrum for next-generation terrestrial networks, to be discussed at the next World Radiocommunication Conference (WRC) in 2007, will come at the expense of satellite allocations, especially for the C-band frequencies. Two thirds of the communication satellites manufactured in Europe have C-band capacity. Consultees were of the opinion that there was a significant inertia within Member States to consider the role of satellites, compared to well established terrestrial networks.

However, there is some suggestion that the current process (first come first served via the ITU procedures along with satellite network cost recovery fees) has shown an improvement over what was there before the fees were established. It is thought that this will further improve with time and should eliminate a great deal of speculation.
Oberst (2007) identifies a number of regulatory issues associated with spectrum management, including:

[24] Section 1.18, Radio Regulations.

- the review of the electronic communications regulatory framework being undertaken by the Commission, with proposals expected in 2007. This is expected to include greater emphasis on pan-European licensing and regulation as well as more authority at the European level on spectrum allocations. Oberst (2007) notes that there are moves in Europe to apply more flexibility to spectrum management; and

- numerous allocations are being debated at various levels in the European Electronic Communications Committee (ECC), which represents 47 European countries. These decisions have a certain influence for market developments, including the C-band spectrum that the satellite sector seeks to protect from terrestrial interests.

Pasco (2006) suggests that the exploitation of GEO may be one of the most contentious international space issues, noting that some countries, such as Iran, with an increasing interest in space, have filed requests to the ITU to change some of the rules. This move has questioned the traditional international balance underlying those rules, for example, demands for non-permanently attributed slots are growing and have become a key issue at the ITU level. Stakeholders identified problems associated with the frequency allocations for Galileo and GMES, due to increasing requests from other users limiting the frequencies available.

Some stakeholders noted that the whole area of frequency allocation is a concern, requiring detailed consideration of spectrum requirement. The ESA has been active in addressing these issues, but institutions have to rely on Member States to take action. Many stakeholders would welcome a key role for the Commission in coordinating frequency allocation actions in the interest of European programmes, where this would be based on advice from ESA, through its Radio Spectrum Committee (RSCOM) and its Radio Spectrum Policy Group (RSPG). Stakeholders believe that the Commission has a significant role to play in order to ensure coherence between European actors in international fora and to ensure that the strategic and political dimensions of space activities are taken into account in European regulatory positions, whether they apply to telecommunications, navigation or scientific space services.

The coordination of national policies at European level is important to satellite businesses which inherently rely on high certainty, over a certain period of time according to the business cycle of the sector, and on EU-wide harmonised spectrum allocations or designations. However, it is suggested that the general trend of spectrum management is to systematically evaluate spectrum efficiency in economic terms, without taking due care of the industrial, social or European-wide benefits which are objectives enshrined in the EU Framework on E-communications. This seeds the risks of making radio spectrum attractive for speculation and creates incentives for spectrum hoarding that does not benefit an "optimised" assignment process.

In conclusion, consultees acknowledge that the process of spectrum allocation is an international system, and is therefore difficult to change quickly. However, consultation suggests that the current ITU allocation generally works well and improvements have been implemented in recent years. However, implementation by Member States varies, which can provide an unfair advantage to companies in some Member States. Consultees would welcome greater European involvement in a coordinating strategic role, in discussion with industry and space agencies; however, all agreed that Member States should retain their individual votes on the ITU. The issue of spectrum allocation will increase in importance in the future as emerging space markets request more positions.

3.4 The World Trade Organisation (WTO) Regime

Ultimately, global industries require market access. To quote a famous example from the satellite communication services industry, the original Iridium and Globalstar projects for global personal satellite communication systems both failed, largely because of the failure to achieve global market access for the services they intended to deliver.

The World Trade Organisation (WTO)[25] is the result of decades of global efforts at liberalisation of trade, which started with the establishment of the General Agreement on Tariffs and Trade (GATT)[26] in 1948. However, its involvement in the space sector is more recent and is essentially limited, so far, to the area of satellite communication services.

In terms of international trade harmonisation of space services it should be realised that, from a global perspective, various states adhere at various levels to obligations under the WTO and in particular the General Agreement on Trade in Services (GATS)[27] – and a considerable number of states, of course, have yet to become members of the WTO and/or party to the GATS. This principally determines the extent of their obligations to allow any European (or other) operator to offer and provide services on their respective national markets.

The telecommunications sector has only relatively recently become the subject of liberalisation efforts in the context of the WTO/GATS. The establishment of WTO and GATS by 1994 led to the first fundamental discussion on liberalising telecommunications worldwide, which meant *inter alia* that general principles of the WTO such as transparency, liberalisation of trade as normally based on reciprocity, as well as the key concepts of ‘National Treatment’ and ‘Most-Favoured-Nation’ would

[25] Established by the Agreement Establishing the World Trade Organization, Marrakesh, done 15 April 1994, entered into force 1 January 1995; 1867 UNTS; UKTS 1996 No. 57; ATS 1995 No. 8; 33 ILM 1125, 1144 (1994).

[26] General Agreement on Tariffs and Trade, Geneva, done 30 October 1947, entered into force 1 January 1948; 55 UNTS 194; TIAS 1700; ATS 1948 No. 23.

[27] General Agreement on Trade in Services, Marrakesh, done 15 April 1994, entered into force 1 January 1995; ATS 1995 No. 8.

be applied to the sector. In addition, existing dispute settlement procedures would thereby become available for solving disputes in that particular sector.

The result was the 1997 Telecom Agreement, as part of the Fourth Protocol to the GATS[28]. It comprised a fundamental effort to liberalise basic international telecommunication services including public telephony, fax and suchlike, and satellite communications as well. However, the way in which this Agreement, signed by 54 WTO Member States plus the European Commission (on behalf of the then fifteen Member States) (together covering more than 90% of world trade in telecommunication services), was structured, (still) allowed for a lot of discretion for individual states to determine where liberalised access to foreign service providers would apply.

Individual schedules of commitment were drafted, indicating for which types of telecommunication services the respective national markets would be opened to international competition by applying the ‘Most-Favoured-Nation’ concept – on the basis of reciprocity. In other words: states allow service providers from other states to offer (a) set(s) of services on their respective territory wherever their own service providers would be allowed to offer the same set(s) of services on the territory of such other states.

In many cases, this included Fixed Satellite Services (FSS) and Mobile Satellite Services (MSS) systems and the services delivered by means of them. With respect to FSS terminals and basic services, 36 schedules of commitment were listed (35 states plus the Union), with respect to MSS terminals and services there were 37 (36 states plus the Union) schedules of commitment and with respect to value-added services there were 44 (43 states plus the Union) schedules of commitment[29].

As a consequence, a distinct measure of liberalisation of international trade in satellite communication services, on an essentially bilateral basis but through a multilateral framework, has come about in a major part of the world.

Finally, as already indicated above, the WTO represents one of the few cases where, as a consequence of the level which European economic integration in the context of the EC and EU treaties has reached, the European Commission is coordinating and controlling the Member States individual inputs since the European Union as such is a member of the organisation.

The major reason for that is the internal level of integration and harmonisation of economic and trade policies within the Union. For the non-EU members of the WTO, it simply did not make sense to be confronted in any international discussions on trade

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28 Agreement on Telecommunications Services (hereafter Telecom Agreement), Geneva, done 15 February 1997, entered into force 5 February 1998; ATS 1998 No. 9; 36 ILM 354 (1997); respectively Fourth Protocol to the General Agreement on Trade and Services of 15 April 1994, Geneva, done 15 April 1997, entered into force 5 February 1998; ATS 1998 No. 9; 33 ILM 1167 (1994).

29 See e.g. Room Document No. 11, of 10 April 1997, submitted by the WTO to the Working Party on Telecommunications and Information Services Policy of the Organization for Economic Co-operation and Development (OECD), at 1.

liberalisation with individual EU member states having to refer to the EU organs since, under existing EC law, they were no longer entitled to individually negotiate on those issues. Hence, they accepted the – still rather exceptional – construction of the Union, a partly intergovernmental, partly supranational organisation, becoming a member of the intergovernmental organisation that was the WTO.

This allows the Commission – hopefully in close consultation not only with the Member States but also with the European space industry – to take up and defend the cause of the latter; it certainly has the competencies to do so[30]. In this context, a fundamental further point for investigation concerns the extent to which the European space industry would be helped by an effort to extend the workings of the key GATT, WTO and GATS principles and rules to other sectors than those of the satellite communication services industry. This could for example refer to the case of Galileo and value-added positioning, navigation and timing services (to be) developed using Galileo services.

Some consultees noted the strategic nature of space, and considered that it would not be pragmatic to change the overall market structure, but that it should be made as open as possible. Despite the progress at the world level discussed above, there is still a suggestion that significant market barriers exist, affecting European activity in countries such as China, India, Argentina, Brazil, Indonesia, Kazakhstan, Russia, and Saudi Arabia.

There is a view that European governments and policymakers can help alleviate this problem by giving high priority to telecommunications services in general, and satellite matters in particular, when conducting multilateral trade discussions or negotiating a specific country's accession to the World Trade Organization (WTO). Moreover, European governments can assist operators in enforcing existing obligations under trade and tax treaties and other agreements as and when necessary.

3.5 Liability Issues Relating to Space Debris

A general issue, which is increasingly worrying the space sector as a whole, concerns the issue of debris of all sorts resulting from space activities. At the outset it should be reiterated that this is an issue more of, on the one hand, a technical/operational nature and, on the other hand, a political and financial character, hence, a specific focus on legal and regulatory issues does not yet seem very relevant.

For that purpose, the present section will briefly address some of the (possible) legal ramifications of this issue, notably by focusing on five elements, and further refer to the many discussions taking place, within the United Nations and individual space agencies as much as between experts (technical as well as legal), on the need to develop further laws, standards or procedures to try and deal with the problem.

[30] Cf. also Art. 300, Treaty of Amsterdam Amending the Treaty on European Union, the Treaties Establishing the European Communities and Certain Related Acts, Amsterdam, done 2 October 1997, entered into force 1 May 1999; OJ C 340/73 (1997).

The first element concerns the definition of 'space debris' as a clearly distinguishable category of 'space objects', since that would allow the clear delineation of when a satellite or part of it may be seen to have been legally abandoned, allowing others to take appropriate measures. By way of comparison, in the law of the sea, the concept of 'salvage rights' exists, meaning others than the original owner/operator are entitled to appropriate the abandoned item under certain circumstances, but that indeed requires a well-defined concept of "abandonment".

A second, related element concerns the application of the space law liability regime to damage (to other satellites) caused by space debris. Such damage to be compensated, as far as under the 1972 Liability Convention, is limited to direct physical damage caused by a space object, not (with a view to exploration-by-looking) to any damage consisting of, or the result of, interference with radio wave usage[31]. This might be a point to work on for the future, if such damage is considered important enough to deal with in a legally binding manner; it appears that the current general liability principles will not be coherent enough to ensure proper solutions here.

This liability regime, as developed by the Liability Convention, is further characterised *inter alia* by state liability under a fourfold definition of the "launching State", meaning that also if private space activities are at issue, international claims will have to be answered by the relevant state(s)[32]. As a consequence, the principle issue of national (space) legislation, including licensing and insurance regulations dealing with reimbursement of state liability, arises – and merits more attention below.

Pasco (2006) notes that there are issues concerning the ambiguity of such notions as "launching state" and space vehicle "registration". The notion of "launching state" implies legal responsibility should a problem occur during the launching phase; however, this notion is ill-defined, as it could be any state that actually launches or orders the launch, as well as any state whose territory and facilities are actually used for the launch. It is noted that the diversity of the possible situations has led to cases in which several states are legally responsible for the same launch, which would increase ambiguity should any difficulty occur. Therefore, Pasco (2006) notes, private operators of launch systems tend to limit their responsibility very precisely. For example, the European launching firm Arianespace limits by contract its responsibility to the rocket propulsion stages, with the customer being obliged to take all necessary measures to register its satellite and give its own state legal responsibility for the satellite thereafter.

With regard to registration, only one state of registry can exist for any satellite in theory. However, Pasco (2006) notes that in reality, the multiplication of actors in

[31] See Convention on International Liability for Damage Caused by Space Objects (hereafter Liability Convention), London/Moscow/Washington, done 29 March 1972, entered into force 1 September 1972; 961 UNTS 187; TIAS 7762; 24 UST 2389; UKTS 1974 No. 16; Cmnd. 5068; ATS 1975 No. 5; 10 ILM 965 (1971). "Damage" is defined by the Liability Convention as "loss of life, personal injury or other impairment of health; or loss of or damage to property"; Art. I(a).

[32] See Art. I(c), Liability Convention

space and their often multinational status have complicated these registry issues, leading to a number of unregistered operational satellites.

Furthermore, while absolute damage applies in respect of damage caused on the ground, fault liability applies when it comes to damage caused to other space objects[33]. Compensation of damage is, in principle, without limit[34]. Claims under the Liability Convention can only be asserted by a limited number of states, but such claims do not stand in the way of private actions in national courts or tribunals[35].

Other problems with liability for damage caused by space debris have not been entirely solved either. The applicability of the liability regime here hinges on space debris being defined as a 'space object' – since it is only damage caused by such a space object which triggers such liability[36].

More importantly, any application of liability (and any consequent claim for compensation to the liable state(s), being the "launching State(s)") depends upon the identification of the launching state(s), which in case of smaller pieces of space debris or of considerable time lapses after break-up may be impossible to bring about.

Whilst the tightening of the requirements of registration of space objects under the 1975 Registration Convention[37] may, to some extent, alleviate this problem, there will always be space debris that cannot be traced back to an original launching state. Thirdly, for those cases, mechanisms such as an 'International Compensation Fund' have been proposed, but it goes beyond the scope of this analysis to deal with those.

Fourthly, in terms of relevant operational procedures to follow to alleviate the space debris problem, various forms of de-orbiting and re-orbiting measures have been discussed. So far they have led to voluntary standards adhered to by some of the major space agencies involved, but these are gradually evolving into proper legally binding rules and obligations, at least on a national level, in some countries.

Fifthly, development and increased implementation of safety standards would go some way to diminishing the impact of space debris. So far, it is in the area of the use of nuclear power sources on board spacecraft that this has developed furthest. A UN Resolution of 1992 provides for a number of guidelines in this respect that may soon develop into customary law with binding force[38].

33 See Artt. II, resp. III, Liability Convention.

34 See Art. XII, Liability Convention.

35 See Artt. VIII, resp. XI, Liability Convention.

36 See Artt. II-V, Liability Convention.

37 Convention on Registration of Objects Launched into Outer Space (hereafter Registration Convention), New York, done 14 January 1975, entered into force 15 September 1976; 1023 UNTS 15; TIAS 8480; 28 UST 695; UKTS 1978 No. 70; Cmnd. 6256; ATS 1986 No. 5; 14 ILM 43 (1975).

38 See Principles Relevant to the Use of Nuclear Power Sources in Outer Space, UNGA Res. 47/68, of 14 December 1992; UN Doc. A/AC.105/572/Rev.1, at 47.

Pasco (2006) notes that the Inter-Agency Debris Committee (IADC) was created in 1993 under the auspices of the United Nations and comprises the main national space agencies and the ESA. Since 2001, the IADC has encouraged the adoption of guidelines at the UN level. At the European level, a cooperative effort is underway to propose preventive and protective measures for activities in LEO and in GEO. These efforts to propose an international norm are coordinated in the framework of the IADC in support of the UN Committee on the Peaceful Uses of Outer Space.

Whilst stakeholders recognises this as an issue of increasing importance, there is concern that any measures taken to address the issue of space debris should not impose undue burdens on the space industry. It is noted that liability rules are applied differently amongst European countries, and this can create a disadvantage for small companies. Others identified existing codes of practice as having an impact on industry, as developing satellites and launchers to meet the requirements is more expensive, but stakeholders considered this necessary for the benefit of future activities and for the 'good health' of space. However, it was also noted that there is a difference between countries and regions at the international level, which may affect the European industry in the short-term, with regard to costs and competitiveness, and in the longer term regarding the impact of increasing debris.

Several consultees identified the need for an autonomous surveillance system; at present Europe is dependent on external information from the US and Russia. Two design studies for a European Space Surveillance System (ESSS) have been conducted for ESA since 2002. Pasco (2006) suggests that the main challenge will be to maintain a catalogue of orbital objects providing a genuine analytical capability and allowing, for example, links to be formed between detected debris and their common origin (e.g. a given satellite that exploded in orbit).

Even once the source of debris can be identified, proof of damage will be required and differences in commercial law amongst European countries are likely to cause difficulties in dealing with liability issues.

In conclusion, the issue of liability associated with damage caused by space debris appears to have many complicating factors which require further examination in order to build on the work already started by existing codes of practice. However, it should be remembered that satellites are far more likely to be damaged during launch and due to technical failures which has created a healthy space insurance industry[39].

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[39] Globally, satellite insurance premiums are about €730m/year (60% for launches and first year operations and 40% for subsequent in-orbit operations). Premiums are of the order of 15-20% for launch and first year operation and around 2% per annum thereafter (IAF, 2006).

3.6 The Satellite Directive (EC Directive 94/46)

Satellite communication services are the major single area where private space activities (as opposed to private space manufacturers) have taken a fundamental foothold, in Europe and internationally. At the same time, it basically constitutes a sub-area within telecommunications at large, where the Green Paper of 1987 on telecommunications constituted the first indication of future EU legislative involvement in the area, even if it, at least initially, explicitly excluded satellite communications from its scope[40].

The Green Paper provided for general policy proposals on market liberalisation and the ensuing privatisation of telecommunication services, and soon resulted in the first pieces of EC legislation[41] as well as legal cases up to and including those before the European Court of Justice[42].

These general trends were then carried forward by the Green Paper of 1990 which specifically addressed satellite communications[43]. In it, the policy aims of the Commission were listed as:

- full liberalisation of earth segments;
- making the competition regime apply to satellite communications;
- achieving unrestricted access to space segment capacity;
- realisation of commercial freedom to market space segment capacity; and
- the bringing about of a separation of regulatory and operational functions in the area of satellite communications.

40 Towards a Dynamic European Economy – Green Paper on the Development of the Common Market for Telecommunications Services and Equipment, Communication by the Commission, COM(87) 290 final, of 30 June 1987; OJ C 257/1 (1987). It was approved by the Council in 1988.

41 Cf. Commission Directive on competition in the markets in telecommunications terminal equipment, 88/301/EEC, of 16 May 1988; OJ L 131/73 (1988); Council Directive on the establishment of the internal market for telecommunications services through the implementation of Open Network Provision, 90/387/EEC, of 28 June 1990; OJ L 192/1 (1990); and Commission Directive on the competition in the markets of telecommunications services, 90/388/EEC, of 28 June 1990; OJ L 192/10 (1990).

42 Cf., as to the Directive on Terminal Equipment, e.g. France v. Commission of the European Communities, Case C-202/88, Judgement of 19 March 1991; [1991] ECR I-1223; as to the Directive on Open Network Provision, see e.g. Ninth annual report to the European Parliament on Commission monitoring of the application of Community law, COM(92) 136 final, of 28 September 1992; OJ C 250/1 (1992), at 35; as well as Italy v. Commission of the European Communities, Case 41/83, Judgement of 20 March 1985; [1985] 2 CMLR 368; [1985] ECR 873; and the underlying Commission Decision, No. 82/861/EEC, of 20 December 1982; OJ L 360/36 (1982); and as to the Directive on Competition in Telecommunications Services, see e.g. Spain, Belgium, Italy v. Commission of the European Communities, Joined Cases C-271, C-281 and C-289/90, Judgement of 17 November 1992; [1992] ECR I-5833; OJ C 274 (1990); OJ C 326 (1992).

43 Towards Europe-wide systems and services – Green Paper on a common approach in the field of satellite communications in the European Community, Communication from the Commission, COM(90) 490 final, of 20 November 1990.

With regard to the last of these, the lack of separation had existed as a consequence of the old system, where telecommunications were provided by governmental entities. After its adoption of the Green Paper by a Resolution in December 1991, the Council ordered the Commission to draft deregulation measures, to be submitted to the Council and the European Parliament for final review[44].

The most fundamental legislative measure taken by the Commission since the Green Paper is the 1994 Satellite Directive, which started to apply a number of legal rules and obligations to the satellite communication sector[45]. Under the Satellite Directive, there were to be no more monopoly rights for incumbent (largely still public) telecommunication operators, the provision of special rights to operators as public service providers would be subjected to stringent requirements, the competition regime would be made applicable to satellite communications and enforcing Decisions by the Commission were to follow.

The Satellite Directive did not achieve all of the objectives put forward by the Commission. For example, the Satellite Directive excluded voice telephony and telex, both of which had to be subsequently liberalised by the 1996 Directive on Full Competition[46]. Also, in the area of the so-called ‘hand-helds’ (satellite personal communication systems) more specific legislation was required – and came about in 1996 and 1997[47].

In terms of harmonisation of licensing, the Satellite Directive only spelled out issues which satellite communication licenses would be allowed to deal with, and since licensing still remains a matter of national competence, there is no proper harmonisation yet. Efforts to deal with this, working towards (ideally) a ‘one-stop-shopping’ system for licenses, achieved some progress, but stopped short of any EU-level licensing or even mutual recognition of national licenses[48].

As a consequence of the limited scope of the Satellite Directive, a number of further legislative documents followed after 1994, dealing with more focused issues such as cable networks[49]. With the recent developments towards digitalisation and

44 Council Resolution on the development of the common market for satellite communications services and equipment, of 19 December 1991; OJ C 8/1 (1992).

45 Commission Directive amending Directive 88/301/EEC and Directive 90/388/EEC in particular with regard to satellite communications, 94/46/EC (hereafter Satellite Directive), of 13 October 1994; OJ L 268/15 (1994).

46 Commission Directive amending Directive 90/388/EEC with regard to the implementation of full competition in telecommunications markets, 96/19/EC, of 13 March 1996; OJ L 74/13 (1996).

47 Cf. Commission Directive amending Directive 90/387/EEC with regard to personal and mobile communications, 96/2/EC, of 16 January 1996; OJ L 20/59 (1996); Decision of the European Parliament and of the Council on a coordinated authorization approach in the field of satellite personal communications systems in the Community, No. 710/97/EC, of 24 March 1997; OJ L 105/4 (1997).

48 Cf. Directive of the European Parliament and of the Council on a common framework for general authorizations and individual licenses in the field of telecommunications services, 97/13/EC, of 10 April 1997; OJ L 117/15 (1997).

49 Cf. Commission Directive amending Directive 90/388/EEC with regard to the abolition of the restrictions on the use of cable television networks for the provision of already liberalized telecommunications services, 95/51/EC, of 18 October 1995; OJ L 256/49 (1995).

convergence of telecommunications, computer and information technologies, a host of new EC Directives and Decisions were required[50].

Whilst the foundation for a true Internal Market for satellite communications has been realised, in many aspects and sub-areas considerable work is required to establish a coherent and level playing field within Europe for satellite communication services.

However, discussions with stakeholders did not raise any specific issues relating to the Satellite Directive and regulation in the satellite communication services, beyond those mentioned above (i.e. related to the ITU and WTO). Rather, stakeholders were keen to discuss the general role of competition with the European space market. Such views included a suggested need for European markets to be more active in the security and defence areas (since these require innovative technology), development of a demand-driven business model (by the Commission) and the advantages and drawbacks of the mechanism for allocating resources for ESA programmes. These issues are discussed further in Section 5.

3.7 Global Standards for Components and Services

The final item which the Study Team identified for further discussion was the current process concerning the global standards for components and services.

Firstly, it should be noted that, in principle, two different approaches are feasible – and have been experienced in practice. Standards may come about ‘bottom-up’, through industry cooperation on a more or less voluntary, market-driven basis, taking into account technical advantages which may exist in using certain standards as opposed to others; or they may come about on a more ‘top-down’ basis, where it is considered important for standards to be properly regulated in order to protect perceived public interests, for example in relation to ensuring consumers have access to satellite services and are not discriminated against.

When it comes to the hardware used for telecommunications (including satellite communications), one must realise that standardisation of any type of hardware has been developed, historically speaking, firstly at the national level, and only in the secondary instance (but increasingly) also at the European (the European Telecommunications Standardisation Institute, ETSI) or even global level.

50 Cf. e.g. Decision of the European Parliament and of the Council on a regulatory framework for radio spectrum policy in the European Community, No. 676/2002/EC, of 7 March 2002, OJ L 108/1 (2002); Directive of the European Parliament and of the Council on access to, and interconnection of, electronic communications networks and associated facilities, 2002/19/EC, of 7 March 2002, OJ L 108/7 (2002); Directive of the European Parliament and of the Council on the authorisation of electronic communications networks and services, 2002/20/EC, of 7 March 2002, OJ L 108/21 (2002); Directive of the European Parliament and of the Council on a common regulatory framework for electronic communications networks and services (hereafter Framework Directive), 2002/21/EC, of 7 March 2002, OJ L 108/33 (2002); Directive of the European Parliament and of the Council on universal service and users’ rights relating to electronic communications networks and services (hereafter Universal Service Directive), 2002/22/EC, of 7 March 2002, OJ L 108/51 (2002).

Alongside a practical impetus on the commercial side to harmonise and unify, as much as possible, standards requirements, for reasons partly of safety but often also of economic interests, governments have also tried to establish legal or semi-legal harmonisation of standards requirements and procedures.

Though more properly part of telecommunications, legal developments in standardisation (and the closely related area of certification) have usually taken place in separate fora and along different lines. This has resulted generally in quite different sets of regulators at the various levels being involved; though in particular in the context of ITU, and increasingly also the European Union, some measure of superficial legal coherence between the two separate fields – telecommunications law and standardisation – has been achieved by these two entities, in a sense supervising the developments in the standardisation and certification area.

As for standards relevant for telecommunication services (including satellite communication services) the situation is even more complicated. To a considerable extent, such legislation developed in the European Union regarding the provision of satellite communication services as based upon the 1994 Satellite Directive incorporates, explicitly as much as implicitly, certain standards applicable to those services – which are legally binding, and may lead to legal procedures being started in case of violations. In addition, even more general principles of (in this case predominantly national) law may apply, regarding such concepts as ‘due diligence’ in performing a service or breach of contract. Finally, it should be added here that the above only relates to the European satellite communications industry, though likely similar evaluations would result from analyses of other areas where the European space industry is active.

Industry notes that inter-operability and standardisation are intertwined issues, with inter-operability required to help industry be more competitive, and standards helping industry have a better idea of how the market will evolve. This predictability assists industry with making investment decisions. However, it is noted that this is a difficult issue because standards are also the result of market forces and customers preferences. There is also concern (amongst industry) as to the extent to which any standards developed may become mandatory over a period of time.

The European Cooperation for Space Standardisation[51] (ECSS) initiative began in 1993, following the requests of industry to harmonise their product assurance standards. The aim was to develop a coherent, single set of user-friendly standards for use in all European space activities, replacing the multitude of different standards and requirements unique to each contractor or space agency. The activities of the ECSS now encompass the standardisation of project management, product assurance and engineering activities, and each standard is developed by a working group comprising of industrialists and representatives from the national space agencies in Europe and ESA. Within ESA, there are a number of standardisation boards

51 For further information, see www.ecss.nl

addressing different technical areas. Inclusion of standards in the ESA Approved Standards list makes their use mandatory for future missions.

The stakeholders consulted agreed that there is good progress in standardisation, particularly through the ECSS. However, a number of stakeholders noted the example of the DVB-RCS (Digital Video Broadcast – Return Channel Satellite) which is part of a set of standards for the digital transmission of video and audio streams and also data transmission (i.e. satellite internet). The DVB standards have been developed predominantly be European organisations. At the international level, DVB-RCS (as officially defined in ETSI EN 301 790) is competing against IPoS (IP over Satellite) and S-DOCSIS (Satellite – Data over Cable Service Interface Specification). Consultees indicate that the S-DOCSIS standard (developed in the US) is cheaper to meet, and therefore is likely to become the dominant standard (particularly for consumer units), as S-DOCSIS systems are able to utilise inexpensive off-the-shelf components. Consultees suggest that DVB-RCS is likely to disappear in the future and it will be necessary to buy US technology to comply with the standards. In April 2006, the European Commission launched an *Action Plan for European Standardisation* (European Commission, 2006). This was developed by the Commission, in conjunction with the European Free Trade Association, the European and national standards organisations, the Member States and stakeholders. It notes that standardisation remains a voluntary, consensus-based, market-driven activity, carried out by a number of stakeholders; thus the main influence on the work, it is suggested, must originate from stakeholders. With regard to space, the Action Plan identifies the key task as launching a new standardisation initiative, with the aim:

- to ensure a proper safety level in space activities;
- to mitigate space related harms such as debris;
- to support European Union policies such as Galileo;
- to contribute to the further development of satellite end-user applications (e.g. navigation, telecoms); and
- to ensure the international competitiveness of the European space industry.

Industry identifies a number of areas where standards could be further developed/ harmonised, including:

- interoperability amongst military systems as a key issue, with examples of duplication of ground station infrastructures across European countries;

- interoperability between EU and US space based systems could be improved and that a first step in this direction could be performed with the further development of GPS/Galileo;

- the operational backup launch of satellites requires technical compatibility, common adapters between satellite and different launcher; and

- in most standardisation activities, software is forgotten and causes many delays and cost overruns in space projects, therefore standards for end-to-end systems could be very beneficial.

In conclusion, some consultees believed that that the European development of standards could be too complex and over technical, resulting in costly solutions. It was felt that the development of the standards needed to be focused on the markets and provide cost-effective solutions, in order to enable industry to meet consumer demands. In general, consultees favoured more standardisation, but some suggested that it is not as decisive for the space sector as it is for other industries.

3.8 Additional Issues

An additional issue (to those identified by the study team) has been raised through the Commission's initial consultation. This notes that there is an imbalance among countries as to the degree of protection afforded by national legislation regarding trademarks, patents and satellite data copyrights. The process of address different national procedures is suggested to be complicated, lengthy and expensive. However, this issue was not raised by other consultees.

A further issue is that of 'shutter control' where countries may have restrict the operation of Earth observation satellites for reasons of national security. National policy in this area is suggested to be flexible and it may be an issue in the future, particularly if the Earth observation market becomes more commercial than institutional.

3.9 Conclusions

The key regulatory issues for the European space industry have been discussed above, and it is of note that a number of these are currently being addressed at the European level. Recent developments include:

- identification of a need to launch a new standardisation initiative (April 2006);
- proposals to revise the dual-use export controls in Europe (published December 2006);
- proposals for changes to the regulatory framework for electronic communications networks and services (expected early 2007); and
- preparations for the World Radio communications Conference in October 2007.

It is assumed that the development of these proposals and the subsequent work to be undertaken will involve further stakeholder consultation, and will therefore address many of the concerns raised here.

There was a little concern (beyond the above issues) from consultees regarding the implementation of the Satellite Directive, and, whilst ITAR was noted as a key issue for industry, stakeholders have developed ways to work with it and it was felt that the Commission's ability to change ITAR was limited. However, across a number of the topics, such as ITAR, ITU and WTO, stakeholders repeatedly requested a 'strong European voice' with the relevant authority to coordinate and to promote the interests of the European space industry in global fora. This issue is addressed further in Section 5.

The remaining issue, which requires further examination, is that associated with liability issues relating to space debris. Whilst stakeholders noted the development of codes of practice, it was suggested that this is a key area where regulation could be introduced to provide greater certainty and harmonisation across Europe. Failure to address this issue may result in significant costs to the European space industry in the future as the problem increases. However, this is a global issue, with international fora, and thus any measures taken would have to consider the existing framework and the relative positions of other space markets.

4. DEMAND SCENARIO ANALYSIS

4.1 Overview

The Project Specification requires that realistic demand scenarios are compiled for the next 15 years to represent a range of future demand; the full demand scenarios therefore cover the period from 2007 to 2021.

The demand scenarios have been developed based on an examination of predictions for:

- the future worldwide space commercial market, including:
  - space application market forecasts; and
  - commercial space transportation forecasts (number of launches foreseeable, for the different categories of satellites, per market);
- the future European civil institutional market;
- the future European defence institutional market; and
- the use of constellations of satellites vs big platforms.

In developing these scenarios, consideration has been given to a number of sources, including Euroconsult (2004, 2005a and 2005b), ASD-Eurospace (2006), AST & COMSTAC (2006) and OECD (2004). Most of these sources provide an indication of the predicted markets over the next ten years (from the date of publication). These are mostly ‘business-as-usual’ scenarios and are based on a bottom-up analysis of existing orders, predicted replacements of in-orbit satellites and general indications of likely demand, under a continuation of current socio-economic and political conditions. However, the last of these sources, OECD (2004), provides scenarios for the space industry to 2030 based on possible geopolitical developments, socio-economic developments, developments related to energy and the environment, and technology developments.

The full discussion on the future markets and the development of the demand scenarios can be found in Annex 3. This section focuses on the scenarios as selected by the Project Team and the Project Steering Committee. These four scenarios are summarised in Table 4.1 (overleaf) and are discussed in more detail below.

It is noted that satellite orders for the next few years have already been placed, thus each scenario follows the same path from 2007 to 2011, after which time they diverge according to the conditions set out below.

Table 4.1: Demand Scenarios				
	BAU Scenario	**Scenario 1**	**Scenario 2**	**Scenario 3**
Commercial Market				
Demand	+4% pa	+7% pa	+3%	-10% pa
Technological Development	Medium	High	Medium	Low
Competition against Space Industry	Telecom – High EO - Medium Navigation - Low	Telecom – Medium EO - Low Navigation - Low	Telecom – High EO – Medium Navigation - Low	Telecom – V. High EO - Low Navigation - Low
Institutional Civil Market				
European Civilian Budget	+2% pa	+10% pa	+2% pa	No growth
Degree of Cooperation	European and Europe-US	International	European and Europe-US	European
Institutional Defence Market				
Military Action/Threat	Some	Low	Some	High
Degree of Cooperation	National	International	European	None, national only
European Defence Budgets	-2% pa	No growth	+10% pa	+5% pa
Note: EO = Earth observation				

4.2 Business as Usual Scenario

4.2.1 Overview

The business as usual scenario assumes a continuation current economic and political conditions and extrapolates current trends across all three markets. It therefore provides a baseline for comparing the other scenarios.

4.2.2 Commercial Market

Although ASD-Eurospace (2006) suggests that a trend towards recovery for the commercial satellite market can be foreseen, it expects levels of demand to be lower than those experienced in the late 1990s. Recovery in GEO satellite demand should occur by the end of the decade, with a new phase of growth likely, assuming that two market factors will act as mass drivers (Euroconsult, 2004):

- the replacement of existing capacity; and
- the introduction of new satellite services targeting mass markets.

It is expected that regional satellite service providers, particularly in the Asia-Pacific region will provide many of the orders for new satellites. This number, however, may be less than expected given the low rate of replenishment, both on the regional and global arenas (Mitsis, 2005). In the medium-term, the uptake of new services such as ethnic and thematic television channels, high definition TV, DAB, and entertainment services, and VSAT (Very Small Aperture Terminal) networks for small and medium companies and home offices should compensate for the decrease in traditional voice and data traffic on satellites. GEO satellites are already significant players on the Internet market because of their broadcast and multicast advantage (Euroconsult, 2004).

Euroconsult (2004) predicts a total of 274-344 satellites to be launched worldwide over the period 2004-2013; this relates to an average growth rate of 3-5% for GEO commercial satellites (AST & COMSTAC (2006) indicates a rate of 4% from 2006-2015). Trends in LEO commercial satellites are more difficult to summarise as the predicted number of annual launches fluctuates from year to year. Euroconsult (2004) predictions for the market value are an average growth rate of 3%-7%. It is noted that the higher rate may be an overestimate when considering the relative growth of the institutional markets. The demand for commercial satellites is expected to be dominated by GEO satellites for FSS and BSS (Broadcasting Satellite Services) (58%-61%), followed by LEO satellites for MSS (19%-23%). Other applications account for a relatively small proportion of the demand.

Whilst there are currently no commercial MEO satellite systems in operation, the Euroconsult's forecast retains this as a possibility, perhaps for broadband services. Euroconsult (2004) assumes that a new generation of LEO satellite systems might be launched at the end of the decade based on the intrinsic efficiency of LEO satellites coupled with innovative spacecraft and payload designs that would greatly improve the productivity of such satellites. The LEO forecast allows for the replacement of Globalstar or the launch of a new constellation by SES/Orbcomm.

Euroconsult (2004) suggests that decreasing launch prices, generated by more competition, could be expected, especially in the launch market for commercial GEO satellites. Other reasons for a possible decline in launching costs include the use of multiple payload launch capability, split co-manifesting of payloads onto a single launch vehicle and efforts to reduce the launch vehicle to payload cost ratio. In the current competitive environment, cost savings should exert downward pressure on launching contract prices. However, lower launching prices are unlikely to generate much additional revenue as the demand for launching services tends to be rather inelastic (OECD, 2004). The growth of satellite development efforts in countries without indigenous launch capabilities will generate a steady demand for commercial launch services. Most of these missions involve small satellites on modest budgets, so the demand leans towards low-cost, small launch vehicles (AST & COMSTAC, 2006).

AST & COMSTAC (2006) suggests an increase in near-term launches reflects several trends unique to the non-GEO market:

- an increase in countries, companies and international non-profit organisations interested in deploying diverse satellites;
- the availability of low-cost launch vehicles to fit increasingly capable small mass satellites;
- delays in funding which have caused manifests to back up; and

- the confluence of planned replacements for commercial remote sensing and telecommunications satellites.

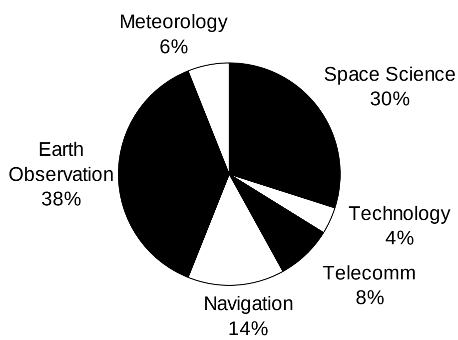
4.2.3 Civil Institutional Market

World civil institutional spending is expected to grow between 2% and 4% annually, driven by the US space programme and Asian countries (Euroconsult, 2005a). There is little expectation of strong growth or decline in the European civil institutional market; sources suggest a stable market (ASD-Eurospace, 2006) at current levels of growth (Euroconsult, 2005b).

The total number of civil satellites predicted for launch during the period 2004-2013 is estimated at 96-109 in Western Europe, out of a total of 357-397 globally. This equates to an average of 10-11 per year. The predicted launch market value ranges from €1,232-€1,257 million.

Figure 4.1 illustrates the proportion of civil satellites by application predicted to be launched worldwide between 2005 and 2010. At a global level, the highest levels of demand are expected to be for Earth observation satellites, and this is also at the forefront of national activities in Germany, Italy and the UK as well as the core of the activities of the emerging countries in space, together with space science. The increased demand from emerging countries is unlikely to lead to major budget increases since many of them will consist of small, low-cost satellites (Euroconsult, 2005a). Key applications during 2004-2013 in Europe are expected to be Earth observation (GMES), telecommunications ('Digital Divide'), and navigation (Galileo).

Figure 4.1: Institutional Civil Satellites to be Launched Worldwide by Application 2005-2010
(source: Euroconsult, 2005a)



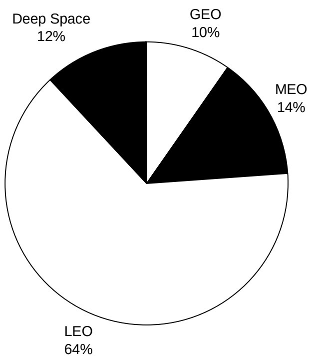
Emerging European civil markets include Poland, the Czech Republic, Hungary, Romania and Turkey. Euroconsult (2005a) suggest that these newcomers will focus on programmes from which they can get direct benefits, principally telecommunications (TV broadcasting, telemedicine, etc) and observation (natural resources management, security and defence). Science and technology programmes may also be a particular point of interest in order to develop local industrial/technological capabilities.

Major meteorology initiatives are being led by civil and military US agencies and European civil institutions, with the objective to upgrade existing systems and to develop increased capabilities. In Europe, EUMETSAT and ESA have a combined budget of $449 million. While the funding level is expected to grow in the US, it is expected to fall in Europe to the $100 million mark with completion of the programmes (Euroconsult, 2005a).

Science budgets tend to be quite stable over time because of constant needs, and scientific programmes require long-term funding for implementation. Therefore, science budgets are not expected to significantly fluctuate in the medium term. However, space exploration initiatives are a key issue in the long term, as programme implementation will require significant funding starting in the next decade.

Figure 4.2 illustrates the predicted division of satellites by orbit worldwide, over the period 2004-2013. Similar data are not available at the European level. However, it is of note that MEO predictions are influenced by the Galileo programme.

Figure 4.2: Institutional Civil Satellites to be Launched Worldwide by Orbit 2004-2013
(source: Euroconsult, 2005a)



The civil LEO satellite market is also growing fast, with the number of civil LEO satellites increasing globally by 52% compared to the past decade. This strong increase reflects the concern shown by civil agencies regarding the cost and lead time of their satellite projects, which encourages them to fund cheaper and smaller but more numerous and more rapidly advancing spacecraft. It also reflects the growing number of countries that are investing in space research and technology for operational objectives such as national resources management, weather forecasting, disaster prevention and also for the development of their industrial capabilities. Technology for small LEO satellites is more immediately accessible to newcomers than other orbits, and these data also reflect the importance of LEO for Earth observation (Euroconsult, 2004).

4.2.4 Defence Institutional Market

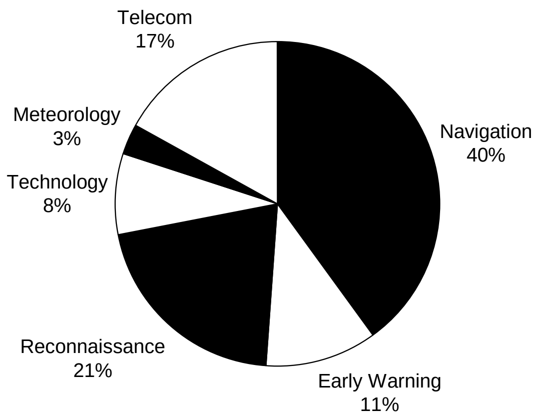
As stated in Section 2, the total value of the global defence space market was nearly $20 billion in 2004 and, in recent years, it has grown at a rate of over 7% per year. However, this is dominated by US spending, and the collective European budget of six countries is much less. Whilst an optimistic global growth of 4% to 6% is suggested, this is unlikely to be reflected at a European level (Euroconsult, 2005a). Defence space budgets in Europe have declined over time, from roughly €900 million in the mid-1990s to €590 million in 2002, however they increased in 2003 in relation to the start of payments for the UK's Skynet-5 programme.

The total number of military satellites predicted for launch during the period 2004-2013 is estimated at 21-28 in Western Europe, out of a total of 190-294 globally. This equates to 2-3 satellites per year. The predicted total launch market value ranges from €583-€774 million, and the total mass is 44-68 tonnes.

The budget deficits faced by most military institutions are encouraging them to optimise their spending for satellite networks through purchase of commercial off-the-shelf (COTS) satellite hardware, lease of capacity or systems from commercial operators and service contracts with private companies under PFI. The success of PPP and PFI should be a key factor for the development of civil and military programmes, meaning strong involvement of private partners and new types of relationships between governments and industry (Euroconsult, 2005a).

Figure 4.3 illustrates the proportion of military satellites by application to be launched worldwide between 2005 and 2010. At a global level, the highest levels of demand are expected to be for navigation and reconnaissance satellites. In particular, GMES will deliver Earth observation data for civil and military-related uses, such as treaty verification and crisis monitoring.

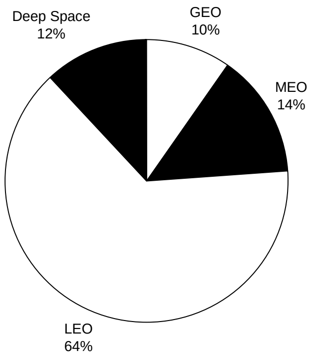
Figure 4.3: Military Satellites to be Launched Worldwide during 2005-2010 by Application, Excluding Classified Programmes *(source: Euroconsult, 2005a)*



Military GEO satellites are expected to be the key growth market, and are likely to become more dominant in European and other non-US markets as military agencies procure dedicated satellites for communication services. The number of LEO satellites for military operators could remain stable, to be launched by a limited number of governments (US, China, Japan, France, Israel, Germany). However, depending upon certain restrictions being removed on technology transfers (as is the case of Earth observation) a higher number of satellites could be required by a larger number of military agencies (Euroconsult, 2004).

Figure 4.4 illustrates the predicted division of satellites by orbit worldwide, over the period 2004-2013. Similar data are not available at the European level.

Figure 4.4: Institutional Military Satellites to be Launched Worldwide by Orbit 2004-2013 (Maximum Scenario) *(source: Euroconsult, 2005a)*



4.3 Scenario 1

4.3.1 Overview

Scenario 1 is based on OECD's (2004) *Smooth Sailing* scenario. It is a relatively optimistic scenario, with a generally peaceful world, the growth of global trade and the internationalisation of production worldwide. Cooperation among nations contributes to the solution of world problems. However, organised crime and terrorism continues to be active, and the environment continues to deteriorate (although less than in other scenarios).

4.3.2 Commercial Market

A more open environment for commercial space is created, and the value of commercial markets grows at 7% per year. New firms from emerging space-faring nations, such as India, Brazil and Israel, enter the industry, and space companies experience fierce competition from within the industry. The space infrastructure that supports trade and commerce is significantly upgraded, and the rate of technology development is high, fuelled by considerable civil institutional investment in space technologies and large R&D budgets devoted to developing innovative space products. Rapid progress in a broad range of technologies fosters high rates of growth worldwide.

The space industry undertakes broad restructuring at the global level to take full advantage of economies of scale, leading to significantly reduced costs of access to space and the development of new services that can fully exploit the advantages of space over terrestrial alternatives. Telecommunications, Earth observation and navigation infrastructures are expanded so as to support the development of global systems and, where relevant, compete successfully with terrestrial networks. Demand for transport and communication services increases substantially, and a comprehensive global Earth observation infrastructure is developed that can be used for civil security as well as commercial purposes. Major advances are made in the manufacture of micro- and nano-satellites.

Export potential is high and foreign direct investment is better protected, as a growing number of developing countries realise that it provides technology transfer opportunities as well as extra investment.

Satellite orders are stable in number but growing in value as satellite technology is highly productive. The satellite industry continues to concentrate as competition from emerging countries is strong.

New applications are developing, especially for direct-to-user services in developed and developing countries, driven by the competitiveness of satellite technology with respect to alternative terrestrial solutions. Communications satellite operators concentrate further as regulatory barriers decrease and get involved in satellite-based Earth observation and navigation.

4.3.3 Civil Institutional Market

All of the world's major space-faring countries cooperate actively on the development of all aspects of civil space, including space exploration and science, basic R&D for the development of space technology as well as on the expansion of space infrastructure. The positive political and economic climate provides a good basis for strengthening international cooperation to deal with the world's principal social problems, such as telemedicine, distance learning through tele-educations services, precision farming, tracking of greenhouse gas emissions, etc.

The European civil institutional market grows at a rate of 10% per year. Such strong growth is driven by space science, exploration and in-orbit infrastructure with costly programmes conducted through large international cooperation. Earth observation is also a strong driver but to a lesser extent as there is a limit to the number of satellites that are required to be launched for that purpose. There are no more budget restrictions domestically for civil space expenditures and space science and exploration is a public priority.

4.3.4 Defence Institutional Market

There is less priority on military expenditures in general, however, space-faring countries outside the United States devote relatively more resources to military space as they strengthen their network centric warfare capability. Thus, European institutional defence budgets are stable under this scenario. Particular attention is devoted to developing an institutional defence space infrastructure in the areas of telecommunications, Earth observation and navigation for carrying out intelligence, communications, command and control functions. There is increased international cooperation between major powers to address the threat represented by states of concern and terrorist groups. The European Common Foreign and Security Policy is reinforced to allow Europe to strengthen its ability to act independently on the international stage, however close cooperation is maintained with the United States on security matters.

Defence space benefits marginally from the civil budget efforts on space science and exploration. Dual-use Earth observation systems, Europe integration and the support of US military satellite capabilities avoid dedicated systems. No military specific applications (e.g. Elint/Sigint, data relay) are developed.

4.4 Scenario 2

4.4.1 Overview

This is based on OECD's *Back to the future* scenario. Three major economic powers dominate the world: the US, Europe and China. The economic power of the US and Europe are gradually weakened and they choose to strengthen ties with each other and to coordinate military forces. This gradually leads to a bi-polar world, where rivalry between Western and Eastern blocs dominates the policy agenda.

4.4.2 Commercial Market

Sluggish economic growth prevails in the West and commercial space activities tend to develop more slowly than in the first scenario, at a rate of 3% per year. A limited but real return to protectionism in the space sector is encouraged by security concerns so that each region develops commercial applications to meet its own strategy. The rate of innovation and technology development in the West is adversely affected by poor economic conditions. Priority is given to military research, including surveillance and communications technologies.

Closer links between North America and Europe result in an integrated space industry. The space industry benefits from institutional investment budgets and dual-use applications may be developed under public-private partnerships, but the industry also suffers somewhat from a less open trade and investment climate. Internal space markets are largely protected and technology transfers between blocs face high regulatory hurdles. The European satellite industry gets closer to the US industry to deliver highly productive satellites worldwide, including to accessible domestic markets. The competition with non-Western manufacturers for commodity satellites is intense and a threat to European manufacturers of such satellites.

Restrictions on information flows (*e.g.* Internet regulations, operator licensing) negatively affect the telecommunications sector, which faces high levels of regional competition from cable operators. The use of space-based navigation systems is widespread for all forms of transport, and faces little competition. Private investors invest less in communications satellites as the growth and profitability story of the sector is less attractive than in other industries. They exit the telecommunications market but do not commit to Earth observation.

4.4.3 Civil Institutional Market

International rivalries result in a large share of civil space budgets devoted to projects likely to create ‘soft power’ in the form of additional prestige or as a way to strengthen or extend international influence. European civil institutional budgets increase at a rate of 2% per year. The range of space applications increases and new dual-use technologies are developed. Significant advances in artificial intelligence, robotics and nanotechnology contribute to cut the cost of space missions. Following the Indian model of space development, many emerging countries place special emphasis on projects using small satellites and available technology to perform specific economically useful missions.

The limited growth in civil budget for space in Europe, within a context of increased cooperation with the US, is directed to Earth observation with limited effort on space exploration. R&D efforts from the European governments are geared toward the development of dual-use technologies for services that benefit military users (satellite navigation, Earth observation and meteorology and communications).

4.4.4 Defence Institutional Market

Growing tensions between the EU/US and another space-faring country leads to a new type of space race and the gradual ‘weaponisation’ of space. EU countries strengthen their common security and defence policy. Military space plays a central role and a core group of like-minded countries agree to coordinate their military space programmes so as to minimise duplication. This leads to the rationalisation and development of Europe’s military space infrastructure. Europe establishes an independent space capability, but also requires interoperability with US military space-based assets. The military space industry of the US and the EU becomes increasingly integrated. The demand for communication and EO satellites increases.

The level of defence funding increases under this scenario, resulting in a major European defence space programme. Dillon (2005) provides a quantitative assessment of what this might mean, suggesting that space defence and security budgets should be increased to €2 billion by 2012, and maintained at this level thereafter. For the purposes of the scenario analysis, this can be assumed to be an average of around 10% increase in institutional (space) defence budgets per year, in order to deliver a European military space programme. Domestic dedicated military satellite systems for communications and Earth observation are replaced and expanded and new military specific applications (e.g. Elint/Sigint, data relay) are developed domestically and through European integration.

4.5 Scenario 3

4.5.1 Overview

This is based on OECD's (2004) *Stormy Weather* scenario; it is a relatively pessimistic scenario. Strong disagreements among major powers lead to a gradual erosion of international institutions and international trade. Economic conditions deteriorate as the world reverts to protectionism and growing social and ecological problems are largely ignored.

4.5.2 Commercial Market

Under this scenario, the commercial market declines at an average rate of 10% per year. This is due to poor economic conditions leading to a reduction in private investment and relatively low rates of innovation, except in the field of military technology. There are limited export possibilities and the rate of technology transfer is low. The restructuring of firms at international level is stifled by national security considerations.

Strong regional barriers to information flows have very damaging impacts on telecommunications services (*e.g.* television via satellite, Internet). The relative progress in space technologies associated with military space gives space operators an advantage over their terrestrial competitors in some cases (e.g. surveillance systems), thus Earth observation and navigation space systems experience low levels of competition. This helps commercial providers of space-based services to maintain revenues in a depressed market. However, space systems in direct competition with terrestrial alternatives (*e.g.* cable operators) suffer major losses of revenues, as markets become increasingly fragmented.

However, selected export markets for space products and services remain open, as a growing number of countries are keen to build a space capability. Space firms benefit from government decisions to purchase space services directly from private sources rather than to create them within government agencies, however, these profit opportunities are heavily regulated and dependent on the budget process. This institutional investment does little to offset the considerable decline in commercial markets.

Satellite orders collapse and various equipment suppliers and integrators exit the market due to structural overcapacity in the market. Private satellite operators exit the market and government-backed operators dominate with preference for local manufacturers.

4.5.3 Civil Institutional Market

Under depressed economic conditions, European institutional civil budgets stagnate. There is no international cooperation and national and regional programmes remain in the forefront. Even though civil budgets are quite limited, some countries still recognise that civil space programmes can be an investment and national civil space research efforts are largely devoted to the development of dual-use technology. This applies notably to meteorology, Earth observation and navigation systems as well as to launchers. From a strategic perspective, Galileo is a key component of the European space infrastructure and helps to ensure that Europe is present on the international scene in all aspects of cutting-edge technologies and provides independence from the US GPS.

With no real growth of civil space expenditures in Europe and a collapsing commercial market, the European space industry concentrates efforts on serving the military market. As a result, equipment suppliers and integrators concentrate.

4.5.4 Defence Institutional Market

In an increasingly hostile world, military space budgets increase worldwide and there is a high level of military action. Military space assets for communication, Earth observation and navigation are developed and strengthened and European military budgets grow at a rate of 5% per year. Although larger space-faring countries increase the resources devoted to their defence capability, cooperation remains limited and does not lead to meaningful integration of defence capabilities. At the European level, national interests are followed with little or no integrated European military effort.

The non integration of European military requirements maintains demand for domestic dedicated military satellites. As a result, no new military specific applications (e.g. Elint/Sigint, data relay) are developed.

4.6 The Achievable Order Book for the European Industry

It should be noted that Section 2 of this Report sets out the *global* commercial market (as requested in the Specification). In order to quantify the achievable order book for the European industry, the European share of the market achieved over the past few years has been further analysed (and quantified) to provide a more robust baseline.

Table 4.2 sets out a summary of satellites manufactured and launched by European companies, as well those to be launched by 2011 as a basis for further analysis. The number of commercial satellites ‘to be launched’ includes an estimate of future satellite orders as the current backlog of orders is for satellites to be launched up to 2009.

Based on the current situation and the changes in markets described under each scenario, expert predictions have been made with regard to the expected number of satellites by market, i.e. the achievable order book for the European industry. These are set out in Table 4.3.

Table 4.2: Satellites Manufactured and Launched over 2002-2006 and to be Launched by 2011 by European Companies												
	Commercial Satellites				**Civil Satellites**				**Military Satellites**			
	Launched*		TBL°		Launched*		TBL°		Launched*		TBL°	
	No.	€m	No.	€m	No.	€m	No.	€m	No.	€m	No.	€m
Satellite m'facturers	24	2600	30	3700	26	1500	69	3500	8	450	24	2800
Arianespace	33	3220			24	1195			8	750		
* satellites launched over 2002-2006 ° satellites to be launched by 2011 *Source: Euroconsult*												

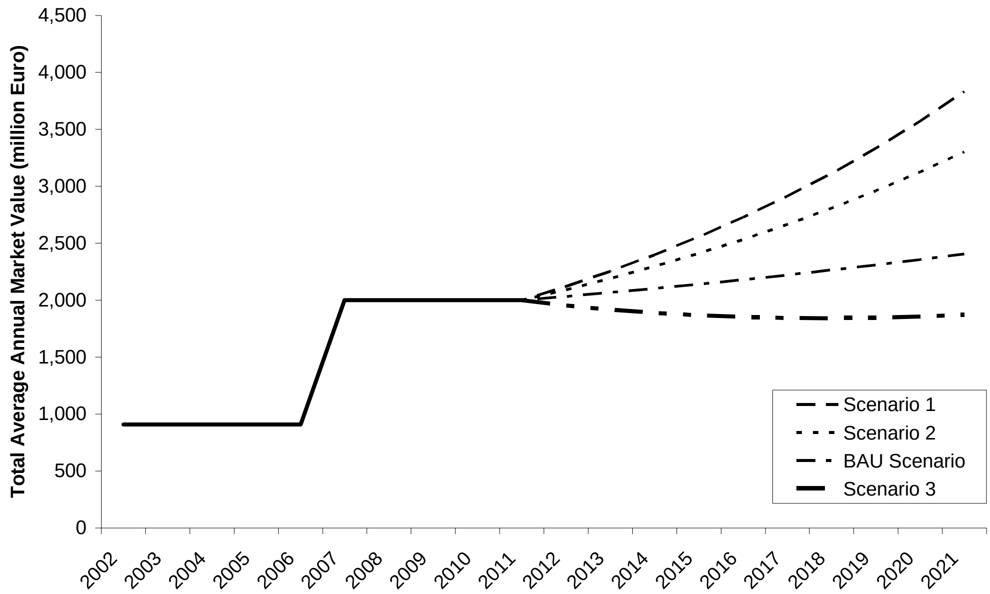
Table 4.3: Predicted Average Annual Number of Satellites Launched by Scenario for 2012-2021				
	BAU Scenario	**Scenario 1**	**Scenario 2**	**Scenario 3**
Commercial Market (Europe)				
Growth rate	+4% pa	+7% pa	+3% pa	-10% pa
Market	Competition from emerging markets increases	Satellite orders are stable in number but growing in value as satellite technology is highly productive.	European & US industry get closer to deliver highly productive satellites worldwide, but limited markets	Satellite orders collapse
Average number of satellites	5 per year	6 per year	5 per year	2 per year
Institutional Civil Market (Europe)				
Growth rate	+2% pa	+10% pa	+2% pa	No growth
Market	Limited growth in civil budget. Lower numbers of high value satellites are launched.	Driven by space science, exploration and in-orbit infrastructure. Earth observation is also a strong driver but limit to the number of satellites that are required for that purpose.	The limited growth in civil budget is directed to Earth observation with limited effort on space exploration.	No real growth of civil space expenditures in Europe, the European space industry concentrates efforts on serving the military market.
Average number of satellites	7 per year	11 per year	8 per year	5 per year
Institutional Military Market (Europe)				
Growth rate	-2% pa	No growth	+10%	+5% pa
Market	European defence requirements for satellite capabilities are served by dual-use European systems and national systems	Dual use Earth observation systems, Europe integration and the support of international defence capabilities avoid dedicated systems.	Dedicated European defence program	Demand for domestic dedicated defence satellites only
Average number of satellites	1 per year	2 per year	6 per year	5 per year
Total average number of satellites	**13 per year**	**19 per year**	**19 per year**	**12 per year**

The Euroconsult data set out in Table 4.2 provide the base assumptions for modelling the achievable order book for the European space industry. This means that all scenarios have the same characteristics between 2007 and 2011, based on current orders. This reflects some inertia, particularly within the institutional markets, to change operational budget lines. The demand growth assumptions, as set out in Table 4.1, have been applied to the average annual market values for the period 2007-2011, to produce quantified demand scenarios for the period 2012-2021. The demand growth assumptions have also been used by Euroconsult to provide projections of the numbers of satellites launched for the period 2012 to 2021, as set out in Table 4.3. An implicit assumption within these projections is that the value per satellite increases in the future, for example, as a result of greater productivity, flexibility or capability. Therefore, the number of satellites has not increased/decreased in proportion to the growth in value.

Combining the data in Tables 4.2 and 4.3 (and allowing for rounding of the numbers of satellites launched) provides projections of the cumulative number of European-made satellites launched over the period 2007-2021. Across all three sectors, 291–371 satellites are predicted. The lowest number of satellites is launched under Scenario 3, and both Scenarios 1 and 2 project the same number of satellites at 371. The Business as Usual scenario lies just below the mid-point, at 321.

The cumulative value of these projections ranges from €33 billion to €43 billion (Scenario 3 – Scenario 1 respectively), over 2007-2021. These figures provide an average value of €3 billion to €4 billion per year, across 15 years. Figure 4.5 illustrates the average annual market value across the four Scenarios.

Figure 4.5: Total Average Annual Market Value for the European Space Industry – Scenario Projections 2007 -2021



The step change in market value from 2006 to 2007 that is illustrated in Figure 4.5 reflects the composition of the data, rather than an actual step change in market value in that year. The data for the period 2002 – 2011 (see Table 4.2) are based on a total market value of €4,550m for the period 2002 to 2006 and a total market value of €10,000m for the period 2007 to 2011. Annual average values reflecting these two totals are illustrated in the graph for these two periods.

During the baseline period (2002-2011) just over half (52%) of satellite launches are in the institutional civil sector, 30% are in the commercial sector and 18% are in the institutional defence sector. Under Scenarios 1 and BAU, the proportion of launches over the period 2012-2021 increases slightly (to 55% in both scenarios) for the institutional civil market, increases slightly in the commercial market (to 31% and 32% respectively), and declines in the institutional defence market (to 14% and 13% respectively). Under Scenarios 2 and 3, the proportion of launches accounted for by the institutional defence sector shows an increase to 25%, whilst the proportion of launches in the institutional civil sector declines to 47% and 50% respectively and the commercial sectors declines to 28% and 25% respectively.

4.7 Maintaining a Sustainable Space and Industrial Technological Base in Europe

Table 4.4 sets out the current structure of the European space manufacturing industry, as derived by ASD-Eurospace (2006), based on the number of companies and employees. These data have been amended as the original source counts national units as different companies, for example, the two launcher system companies are actually EADS SPACE Transportation GmbH (Germany) and EADS SPACE Transportation SAS (France). Therefore, Table 4.4 presents the actual number of companies and the number of national units in brackets.

Table 4.4: Companies (and National Units) and Employment by Type and Segment

Type of Company	Number of Companies in the Supply Chain				
	System	**Subsystem**	**Equipment**	**Services**	**Total**
Launchers	1 (*2*)	11	11 (*12*)	-	23
Satellites	7 (*11*)	2	61 (*64*)	14 (*15*)	84
Ground	-	-	3	30 (*32*)	33
Total	8 (13)	14	75 (79)	44 (47)	**140**
	Employment				
Launchers	2,670	3,490	420	-	6,580
Satellites	12,620	680	4,880	580	18,770
Ground	-	-	160	2,380	2,540
Total	**15,290**	**4,170**	**5,460**	**2,960**	**27,880**

Source: ASD-Eurospace (2006)

As can be seen from the above discussion, the number of satellite orders in the pipeline for launch in the 2007-2011 period is significantly greater than the number of launches in the 2002-2006 period. In the subsequent ten year period, 2012-2021, the achievable order book for the European space industry increases further in three of the four scenarios. Only Scenario 3 projects lower market values than the Business as Usual Scenario (or current markets). However, specific factors will influence the market, as summarised in Table 4.5.

Table 4.5: Summary of Market Factors by Scenario				
Market Factors	**BAU Scenario**	**Scenario 1**	**Scenario 2**	**Scenario 3**
Overview				
Key Areas of Demand and Trends	Commercial satellites for Asia-Pacific region Commercial GEO satellites for FSS and BSS Civil telecoms., navigation and EO satellites Military GEO telecoms satellites Smaller GEO and LEO satellites to meet demand for cheaper technology with more rapid development Flexible satellites to meet changes in demands	Rapid progress in technology development Major advances in micro- and nano-satellites Commercial telecoms, navigation and EO Development of new applications for direct-to-user services Space science and exploration are civil priorities No military specific applications developed, dual-use applications only	Major European security and defence programme Restrictions on information flows adversely affect commercial telecommunications markets Greater commercial focus on dual-use Priority given to military research, inc. EO/surveillance and communication technologies Use of space-based navigation systems is high Limited space science and exploration	National security and defence programmes Restrictions on information flows adversely affect commercial telecommunications markets Commercial market concentrates on surveillance and navigation / dual-use applications National civil programmes devoted to development of dual-use technology
Drivers	Replacement of existing capacity New satellite services targeting mass markets	High civil institutional investment Growth of global trade	Political difficulties Closer cooperation with US High defence institutional investment	Deteriorating economic conditions Political difficulties
Key Import Markets	US, India and Russia	US, Japan, India and Russia	US and India	Limited
Key Export Markets	US, Russia and emerging markets	High potential for exports to emerging markets	Greater protectionism, more limited export markets	Greater protectionism, more limited export markets
Level of Competition from Emerging Markets	Medium	Very high	Low	Low
Level of industry restructuring	Some concentration	Restructuring at global level. Continuing concentration	Some commercial satellite operators exit the market Some concentration at European level	Various equipment suppliers and integrators exit the market Government-backed operators dominate with preference for national manufacturers Restructuring stifled by national security considerations but equipment suppliers and integrators concentrate to the extent possible

It is expected that concentration of the European industry (ASD-Eurospace, 2006) will continue under each scenario, including business as usual. Where this reflects the achievement of a more efficient and competitive position within a positive global market it is likely that the European space and industrial technological base will be sustained. This is likely to be the case across Scenarios 1, 2 and BAU, where investment is sufficient to maintain the market at least at current levels if not higher. Of greater concern is the situation under Scenario 3, where concentration of equipment suppliers and integrators is expected principally as a response to declining market size rather than as a result of measures to improve efficiency.

Imports are likely to be affected across all scenarios, either positively or negatively. Under Scenario 1, Europe's imports for satellite manufacturing are likely to be two fold: on the one hand, technically-advanced subsystems from the US and Japan are imported, such as large antennas and electronic components, and on the other hand there are imports of standardised platforms from lower labour cost economies such as India and Russia. The ability to source satellite equipment and components from outside of Europe is therefore important for competitiveness in the commercial sector. The US is likely to remain a key source of imports (e.g. microwave and radiation-hardened components) as the European industry is unlikely to manufacture some technologies due to high development costs, absence of economies of scale where world demand is so low for specific products and the 'flight heritage' (reliability) associated with US components.

Under Scenario 2 the relationship between the USA and Europe remains strong and the USA will continue to be a key source of some components. Trade relations with other countries may deteriorate however and so imports of standardised platforms from low labour cost economies may decline. Whilst this could contribute to increased employment levels within the European space industry, the higher cost base may have a detrimental effect on orders in the longer-term.

Under Scenario 3, trade conditions deteriorate significantly and imports of technically advanced components from the USA and Japan and low cost standardised platforms from other countries all decline. Restrictions on imports of components from the USA and Japan could have a significant detrimental impact on the European space industry's ability to manufacture cost-effective satellite systems. The development (and manufacture) of some advanced components in Europe might be encouraged, but low economies of scale may result in very high costs of manufacture.

Based on past experience, it is noted that industry is generally responsive and flexible to changes in the composition of demand, largely due to the fact that employees can be moved between space, defence and aerospace divisions of a (large) company. In some cases, companies have allowed unprofitable operations to continue, in order to retain a market share (and employment in key skills)[52], as once a firm exits the market it is unlikely to re-enter due to high sectoral barriers. However, the continuing decline of the market under Scenario 3 may result in significant problems for the industry.

52 Lockheed Martin and Boeing in the US are examples of this.

4.8 Necessary Investments to Ensure the Sustainability of European Technological Knowledge in the Space Domain

Essentially, the European industry is driven by institutional infrastructure and application demand, which is then leased or applied to commercial uses. Institutional funding has therefore played an important role in the past and is likely to continue in the future. Future order books partly[53] depend upon new operators or uses emerging, which in turn requires institutional support, as high costs and risks are involved. The right environment is needed for the private sector to invest more in satellite infrastructure, and this will therefore vary across the Scenarios. High levels of uncertainty about the macroeconomic climate and about the demand for satellite-based services, for example under Scenarios 2 and 3, will have a particularly detrimental effect on the private sector's propensity to invest in satellite infrastructure.

New business models include the use of Public-Private Partnerships (e.g. Paradigm Secure Communications in the UK) and the co-financing of small satellites to prove the technology works and demand exists, at lower cost and risk than for a large GEO satellite (e.g. the Avanti model). Once the technology and business model is proven and uses develop, further funding may then be forthcoming for other satellites; this approach is therefore market driven, in which the infrastructure is built incrementally.

Table 4.6 (overleaf) sets out the levels of investment required by the commercial and institutional sectors under each of the scenarios, in order to maintain the market values indicated above. As stated earlier in the Report, 70% of institutional budgets are purchases from industry (i.e. the market value), therefore an additional 30% is required to 'generate' the demand for purchases, where this is likely to be associated with internal R&D and programme management. A similar situation is likely to occur within commercial entities and, in the absence of better data, the same ratio is used here. Thus, Table 4.6 sets out the level of investment needed to develop the required space infrastructure for 2007-2021. It is noted that additional expenditure would be required across all three sectors to develop user services.

If it is assumed that the current market sustains technical knowledge in the space domain in Europe, then any scenario which is higher than the present market (i.e. Scenarios 1 and 2) are likely to be sustainable. Under Scenario 1, private investment would increase due to market drivers, but is also supported by strong civil institutional investment. Scenario 2 provides a more equal balance of investment across the markets, increasing the institutional defence investment (compared to the current situation), due to the European programme.

However, under Scenario 3, the commercial market collapses and the civil market stagnates as civil budgets are restricted. There is more investment from the military sector in response to the more difficult security situation and this may contribute to maintaining and developing the technical knowledge base in Europe. However, there is less opportunity to sustain technological knowledge under this Scenario.

[53] The replacement of in-orbit satellites of existing operators also drives future demand.

Table 4.6: Estimated Average Annual Investment in Space Infrastructure Required by Private and Institutional Sectors Under Different Future Scenarios (€ million) (on the basis that the 'market value' equates to 70% of the total investment)

	2007-2011[1]	Growth	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
BAU Scenario Budgets												
Commercial	1,057	4% pa	1,099	1,143	1,189	1,237	1,286	1,338	1,391	1,447	1,505	1,565
Civil	1,000	2% pa	1,020	1,040	1,061	1,082	1,104	1,126	1,149	1,172	1,195	1,219
Defence	800	-2% pa	784	768	753	738	723	709	695	681	667	654
Scenario 1 Budgets												
Commercial	1,057	7% pa	1,131	1,210	1,295	1,386	1,483	1,586	1,698	1,816	1,944	2,080
Civil	1,000	10% pa	1,100	1,210	1,331	1,464	1,611	1,772	1,949	2,144	2,358	2,594
Defence	800	0% pa	800	800	800	800	800	800	800	800	800	800
Scenario 2 Budgets												
Commercial	1,057	3% pa	1,089	1,122	1,155	1,190	1,226	1,262	1,300	1,339	1,379	1,421
Civil	1,000	2% pa	1,020	1,040	1,061	1,082	1,104	1,126	1,149	1,172	1,195	1,219
Defence	800	10% pa	880	968	1,065	1,171	1,288	1,417	1,559	1,715	1,886	2,075
Scenario 3 Budgets												
Commercial	1,057	-10% pa	951	856	771	694	624	562	506	455	410	369
Civil	1,000	0% pa	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Defence	800	5% pa	840	882	926	972	1,021	1,072	1,126	1,182	1,241	1,303

Note:

The figures for 2007-11 are based on the order book figures of €3,700m, €3,500m and €2,800m quoted in Table 4.2 for commercial, civil and defence satellites respectively. These equate to annual figures of €740m, €700m and €560m respectively. These 'market values' represent 70% of the overall investment. Hence, investment figures presented above are based on market values divided by 0.7 (e.g. for 'civil' €700m/0.7 = €1,000m).

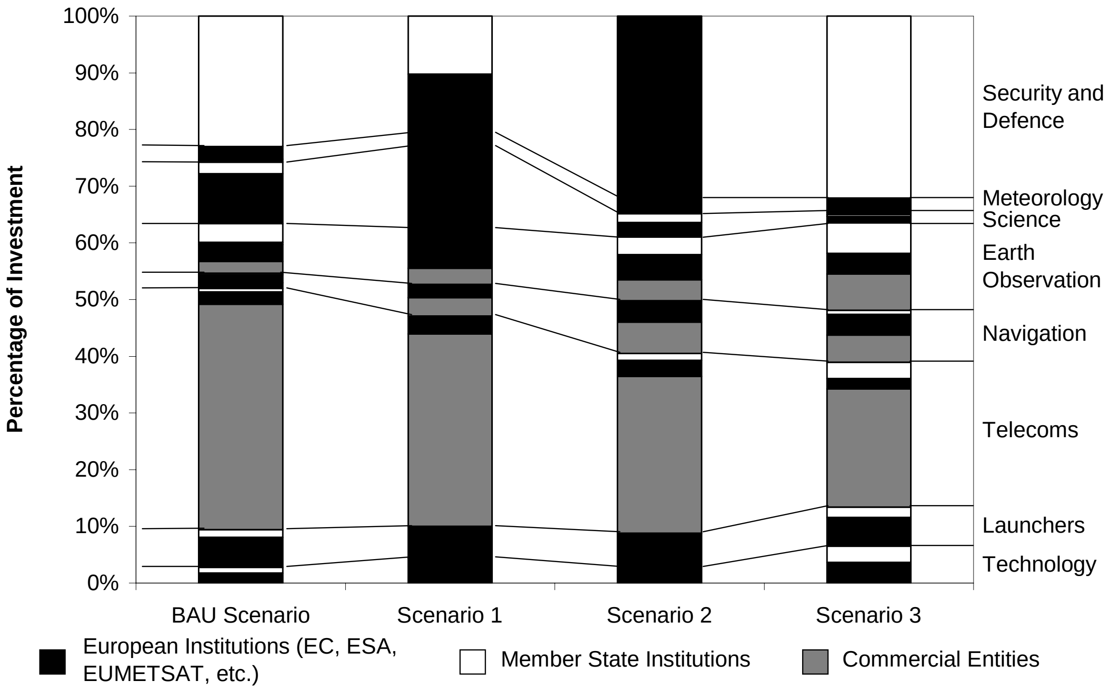
4.9 Roles and Responsibilities of Actors

In order to assess the activities and investments likely to fall to each of the key actors[54] it is necessary to divide the space industry by sector. Therefore, consideration is given to:

- satellite technology;
- launchers;
- telecommunications;
- navigation;
- Earth observation;
- exploration and science;
- meteorology; and
- security and defence.

Figure 4.6 illustrates the current relative expenditure by sector, where the BAU scenario is based on current levels of institutional expenditure. Commercial investment is included, based on the market (baseline) value of satellites launched, and an estimated division between applications, but it is noted that these data are only estimates and are included here for completeness only.

Figure 4.6: Relative Investment by Sector and by Scenario



[54] The European Community; the European Space Agency; Member States, their Space Agencies, defence ministries and regional bodies; the European Defence Agency; and other entities at the European level.

Based on the description of the scenarios, the percentage of investment by actor and by sector has been varied, to estimate how the roles and responsibilities may change by sector. For the purposes of this part of the analysis, European institutions (ESA, European Commission, EUMETSAT, etc) have been considered as a whole, since the key factor is the level of cooperation and integration under each scenario. The assessment of different models for a European institution(s) is set out in Section 5. Thus the key actors are European institutions, Member State institutions (governments, space agencies and defence agencies) and commercial entities.

For example, under Scenario 1, European institutions and commercial entities have a key role to play, with international cooperation and strong global markets driving investment. Member States retain some control over defence programmes, but civil programmes are managed at the European level. However, depending on the management structure adopted (see Section 5) Member States may still have a key role to play in the decision-making of European institutions (and this will be the case across all scenarios). In addition, the relative importance of applications changes, with commercial interests increasing in navigation and Earth observation and therefore taking on greater responsibility for these applications.

Under Scenario 2, European institutions take on responsibility for security and defence applications, whilst Members States maintain some roles in civil applications such as space science, Earth observation and telecommunications. Commercial responsibility is relatively less, due to limited economic conditions. This decreases further under Scenario 3, where commercial entities experience a significant decline in their role. Instead, Member States take on greater responsibility for civil applications, although some activities are still undertaken at the European level, including navigation and meteorology. The role of Member States in security and defence also increases under Scenario 3.

Across all the scenarios, European institutions maintain a key role in the field of launchers and satellite technology development, due to the inability of Member States to fulfil these roles, particularly the former. Under Scenario 3, technology development is divided between European institutions (for civil applications) and Member States (for defence applications).

4.10 Conclusions

This Section has set out a Business as Usual scenario and three additional future demand scenarios for the European space industry. These scenarios represent different economic and political conditions, which will affect the achievable market for the European space industry (where this has been quantified for the manufacturing industry) and the required levels of investment by different actors across the range of applications.

Under Scenario 1, the commercial market is strong and private investment in space increases. Commercial interests increase in navigation and Earth observation and therefore the private sector takes on greater responsibility for these applications. Export potential is high as there are no barriers to global trade, but there is stronger competition from emerging space-faring nations. Therefore, efforts to improve technical capability, competitiveness and efficiency are of most importance under this scenario in order to sustain the European space industry.

Under Scenario 2, European institutions take on responsibility for security and defence applications, whilst Members States maintain some roles in civil applications such as space science, Earth observation and telecommunications. Commercial responsibility is relatively less, due to limited economic conditions. High levels of uncertainty about the macroeconomic climate and about the demand for satellite-based services will have a detrimental effect on the private sector's propensity to invest in satellite infrastructure. While limited imports could contribute to increased employment levels within the European space industry, the higher cost base may have a detrimental effect on orders in the longer-term. European cohesion is most important, and most complicated, under Scenario 2 as a European defence space programme is undertaken in this Scenario. This also emphasises the need to develop technological capabilities for the purposes of security and defence (including dual-use), particularly in the face of poor economic conditions (when innovation is low). Due to the political environment (and further development of emerging industries), access to the global markets is limited, therefore additional efforts are needed to maximise access to the extent possible, requiring a more competitive and efficient industry.

Under Scenario 3, economic conditions deteriorate as the world reverts to protectionism. Restrictions on imports of components from the USA and Japan could have a significant detrimental impact on the European space industry's ability to manufacture cost-effective satellite systems. Member States take a greater role in both civil and military applications. The development (and manufacture) of some advanced components in Europe might be encouraged, but low economies of scale may result in very high costs of manufacture. This would require considerable development of technological capabilities, as well as increasing resource efficiency due to the poor economic conditions. Limited export markets remain open, and these must be exploited to the extent possible, while civil budgets are largely devoted to the development of dual-use technology. There is more investment from the military sector in response to the more difficult security situation and this contributes to maintaining and developing the technical knowledge base in Europe. However, the continuing decline of the commercial market is likely to lead to consolidation amongst equipment suppliers and integrators.

5. ANALYSIS OF ALTERNATIVE MANAGEMENT MODELS

5.1 Current ESA/EC Framework

5.1.1 Overview

The European Space Agency (ESA) is an inter-governmental organisation with 17 members (EU-15 plus Norway and Switzerland). Hungary, Czech Republic, Romania and, most recently, Poland have each signed a Plan for European Cooperating State (PECS) as a formal step towards ESA membership. ESA also has a number of agreements with other countries including Canada[55], Russia and China.

The European Community (EC) cooperates with ESA under a Framework Agreement[56], which came into effect in May 2004. Specifically:

The cooperation under this Framework Agreement between the Parties aims at:

(a) securing Europe's independent and cost-effective access to space and the development of other fields of strategic interest necessary for the independent use and application of space technologies in Europe;

(b) ensuring that the overall European Space Policy takes into particular account the general policies pursued by the European Community;

(c) supporting Community policies by using space technologies and space infrastructures where appropriate and promoting the use of space systems in support of sustainable development, economic growth and employment;

(d) optimising the use of expertise and available resources and contributing to the consolidation of the close cooperation between the European Community and ESA, thereby linking the demand and supply of space systems within a strategic partnership; and

(e) achieving greater coherence and synergy of research and development in order to optimise the use of resources available in Europe, including the network of technical centres.

Other points of note include:

- under Article 5 of the Framework Agreement, European Community space-related activities may be managed by ESA and the European Community may participate in ESA 'optional' programmes (see Section 5.1.5);
- under Article 8, the cooperation is coordinated at policy level by meetings of the Council of the European Union and the Council of ESA (the 'Space Council') and is assisted by a Secretariat (comprising ESA and Commission officials); and

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55 The relationship with Canada dates back to the 1970s and is particularly close (ESA (2002): **Canada and the European Space Industry** - available from www.esa.int/esapub/hsr/HSR-25.pdf).

56 **Council Decision on the signing of the Framework Agreement between the European Community and the European Space Agency**, Council of European Union decision 12858/03 dated 7 October 2003. The Framework Agreement was adopted by the ESA Council in November 2003.

- under Article 12, the Framework Agreement remains in force for four years (i.e. until May 2008) with the provision for automatic renewal for further four year periods. It is also possible for the Agreement to be terminated or renegotiated.

5.1.2 Space Council

The first meeting of the Space Council took place in November 2004 involving all 27 EU and/or ESA Member States. At the meeting, the priority was to establish a European Space Programme in 2005.

The second and third Space Council meetings took place in June and November 2005 respectively and reaffirmed the need to develop a 'European Space Policy and Programme' as well as recognising Galileo and GMES as 'flagship' activities involving EU/ESA cooperation.

5.1.3 European Space Policy and Programme

In recent years, there have been a number of authoritative reports on the evolution of the European Space Policy and Programme and the associated relationship between the EU and ESA. In November 2000, ESA launched the 'Wise Men' report (Bildt *et al*, 2000) which recommended, *inter alia*, that there was an urgent need for the EU to develop and implement a space policy as well as working more closely with the ESA.

This work was carried forward by a Commission/ESA Task Force, established in 2001, resulting in the Space Green Paper (CEC, 2003) jointly prepared by the Commission and ESA. The Commission/ESA Task Force organised extensive consultation on the Green Paper which resulted in the Space White Paper (CEC, 2003a). This concluded with the view that further and closer EU/ESA cooperation was an essential component of the evolution of the European Space Programme. The White Paper also included an Action Plan providing a 'roadmap' for future EU/ESA activities. Concurrently, ESA (2003) published its *Agenda 2007* which included the stated intention of formalising its role within the "framework of Europe's institutions".

However, as Bildt & Dillon (2004) note:

> *But in the short-term, there is no need to engage in lengthy negotiations to integrate the two institutions. This is because there are important institutional differences between the supranational European Commission and the inter-governmental ESA. Both organisations also have different memberships. Instead, EU governments should concentrate on developing space programmes and technologies that would be useful for implementing the Union's various policies, and on promoting a viable and competitive European space industry.*

In response to the first Space Council meeting (held in November 2004), the Commission/ESA Joint Secretariat prepared a Communication on European Space Policy in 2005 (CEC, 2005a). This Communication makes no reference to the White

Paper and appears to provide a 'fresh start'[57]. By way of example, the White Paper emphasises the need to integrate defence issues into the European space policy whereas the 2005 Communication barely mentions 'defence'.

The 2005 Communication appears to envisage the following relationship between the Policy and Programme:

> *This European Space Policy will consist of: a strategy outlining the objectives; the definition of the roles and responsibilities of the main actors in delivering these objectives;* [with] *the European Space Programme identifying the priorities of the main actors; and a set of implementing principles agreed amongst them.*

The division of roles between the EU and ESA is defined as follows:

The role of the EU will be:

- *to define the priorities and requirements for space based systems at the service of the EU's main objectives and policies and citizens' needs;*
- *to aggregate the political will and user demand in support of these;*
- *to ensure the availability and continuity of services supporting EU policies by funding relevant up-stream research activities; purchasing services or securing the deployment and operational phases of space systems, as appropriate; and in due course stimulating user funding;*
- *to ensure integration of space-based systems with related ground and in-situ systems in promoting the development of user-driven application services supporting EU policies;*
- *to create an optimum regulatory environment to facilitate innovation; and*
- *to promote coordination of the European position in international cooperation.*

It will be the role of ESA by decisions of its Member and Co-operating States:

- *to support the technical specification of the space segment of space application programmes, taking particular account of EU requirements;*
- *to develop and implement space technologies, in particular in access to space, science and exploration;*
- *to pursue excellence in scientific research in, of and from space;*
- *to advise the EU on space segment requirements to support availability and continuity of services; and*
- *to implement international cooperation within the ambit of ESA-led programmes.*

[57] This may reflect the switch of responsibilities for space from DG Research to DG Enterprise and Industry in August 2004 (*Portfolio Responsibilities of the Barroso Commission* - Commission Press Release IP/04/1030, dated 12 August 2004).

5.1.4 EU Draft Constitution

An important step (in the longer term) will be the formal ratification of the draft EU Constitution[58] which was rejected by France (May 2005) and the Netherlands (June 2005) and, as a consequence, has not (formally) come into effect. Space was incorporated (along with research and technological development) as follows:

> *In the areas of research, technological development and space, the Union shall have competence to carry out activities, in particular to define and implement programmes; however, the exercise of that competence shall not result in Member States being prevented from exercising theirs.* (Article I-14(3))

Further detail is to be found in Article III-254:

1. *To promote scientific and technical progress, industrial competitiveness and the implementation of its policies, the Union shall draw up a European space policy. To this end, it may promote joint initiatives, support research and technological development and coordinate the efforts needed for the exploration and exploitation of space.*
2. *To contribute to attaining the objectives referred to in paragraph 1, European laws or framework laws shall establish the necessary measures, which may take the form of a European space programme.*
3. *The Union shall establish any appropriate relations with the European Space Agency.*

5.1.5 ESA Programmes

Overview

ESA operates 'mandatory' and 'optional' programmes, where[59]:

- *mandatory activities* (space science programmes and the general budget) are funded by a financial contribution from all the Agency's Member States, calculated in accordance with each country's gross national product; and
- *optional programmes* for which each Member State decides whether they wish to participate and the amount they wish to contribute.

More than three times more is spent on optional programmes than on mandatory programmes (ESA, 2006). Some programmes involve cooperation with other parties including joint projects with the EC (European Community). Key ESA/EC projects include Galileo (and, its precursor, EGNOS) and GMES and these are outlined below.

[58] Full text of the draft Constitution for Europe (as signed by Heads of State on 29 October 2004) and associated information is available from europa.eu.int/constitution/index_en.htm

[59] As derived from ESA's website (www.esa.int).

EGNOS

The European Geostationary Navigation Overlay Service (EGNOS) comprises three satellites and a ground network which are used to increase the reliability of the services provided by the American GPS and Russian GLONASS systems. EGNOS represented the first phase of the development of the European global navigation satellite system, GNSS 1. The second phase, GNSS 2, is the Galileo programme (discussed below).

ESA managed the technical development of EGNOS from the mid-1990s in collaboration with the European Commission, which was responsible for institutional and policy matters on behalf of the EU-15 (as was), and Eurocontrol, which was responsible for defining user requirements for civil aviation. Most of the funding was provided by participating ESA Member States (which included Canada) with substantial contributions from the European Community and the civil aviation sector. By 1998, the project cost was estimated[60] to be about €200m with a completion date of 2002, but by 2003 the cost had risen to about €300m with a completion date of 2004[61]. In the event, EGNOS successfully commenced operations in July 2005.

Galileo

Galileo is a global navigation infrastructure under civil control. It will consist of 30 satellites, the associated ground infrastructure and regional/local augmentations. Following initial research, it was anticipated that the project would evolve as follows:

- development phase (2002-05) at a cost of €1.1bn (shared equally between the Community and ESA);
- deployment phase (2006-07) at a cost to be borne by the Community and private funding; and
- operational phase (2008-) privately financed (but assisted with a Community advance).

The development phase was run by the Galileo Joint Undertaking (GJU), an organisation jointly established by the Community and ESA. The GJU was also responsible for the operations of EGNOS. Although the development phase was not complete, the GJU was disbanded on 31 December 2006[62] and the responsibility for the Galileo system passed to the GNSS Supervisory Authority (discussed further below). In addition to delays in the development phase, costs have risen to, perhaps, €1.6bn (Mattner, 2006).

The timescale for the remainder of the project has been substantially increased with an expectation that all 30 satellites will not now be launched until 2011.

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60 Goldman T (1998): *Signal Providers - EGNOS*, presentation to the World-Wide CNS/ATM Systems Implementation Conference, Rio de Janeiro, 11-15 May 1998.

61 CEC (2003): **Integration of the EGNOS Programme in the Galileo Programme**, COM(2003) 123 final dated 19.03.2003.

62 GJU Press Release dated 30th November 2006.

GMES

The Global Monitoring for Environment and Security (GMES) is a complex system designed to collect and analyse data from a range of sources including satellites. It is intended that GMES services will include mapping, support for emergency management and forecasting[63]. The project is in three phases:

- initial period (2001-03);
- development period (2004-08); and
- operational period (2008-)

The project is funded by ESA and by the Community (via the Framework Programmes - see below). In the first five years, ESA contributed €130m while the Community contributed €100m (via the Sixth Framework Programme). It is envisaged that further significant funding will occur.

As of June 2006, the Commission established the GMES Bureau (located within DG Enterprise & Industry) to provide a focal point for its GMES-related activities with advice provided by the GMES Advisory Council.

Within this area of activity, another important player is EUMETSAT (an intergovernmental organisation[64] formed in 1986) with an operational fleet of meteorological satellites. EUMETSAT is committed to contributing relevant data and products to GMES and, in the longer term, is keen to operate GMES satellites for monitoring the atmosphere and the oceans[65].

5.1.6 R&D Framework Programmes

At a European level, R&D is supported by the EU Framework Programmes. The Sixth Framework Programme (FP6) was superseded by FP7 in January 2007 for the period 2007-13.

EU funding of space science (including GMES) projects has been provided by FP6 and further projects will be funded under FP7 with a budget of €1.4bn for 'space' and a further €1.3bn for 'security'. Specific areas of interest are identified[66] and have been paraphrased as follows:

- *space-based applications at the service of the European Society:*
  - *GMES;*
  - *innovative satellite communication services;*

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63 For more, see www.gmes.info.

64 As of March 2007, EUMETSAT has 21 Member States and 9 Cooperating States. The 21 Member States comprise the ESA-17 plus Slovakia, Croatia, Turkey and Slovenia. The 9 Cooperating States comprise eight of the 12 new EU Member States (not Slovakia, Slovenia, Cyprus and Malta) and Iceland.

65 Further detail on EUMETSAT activities available from www.eumetsat.int.

66 Further details available from cordis.europa.eu/fp7/faq.htm.

- *development of monitoring technologies and systems for reducing the vulnerability of space-based services and for contributing to the surveillance of space; and*
- *development of space-based systems for risk prevention and risk management;*

- *exploration of space:*
  - *maximisation of scientific added value through synergies with the ESA and Member States; and*
  - *coordination of efforts for the development of space-borne telescopes and detectors as well as for data analysis in space sciences; and*

- *RTD for strengthening space foundations:*
  - *space research and development for long-term needs; and*
  - *space sciences including bio-medicine and life and physical sciences in space.*

5.1.7 Summary

Within EU/ESA Member States (at ministerial level) there is a clear desire to develop a European space policy and programme. However, there are views which suggest that more needs to be done to tackle some of the associated issues. For example:

> *The Space Council should be the forum for the key political decisions affecting European space. Currently, it merely serves as a vehicle for general discussion adding a "veneer of space" to EU policies. European statesmen must take responsibility for the financial and institutional requirements needed to lead and to manage the European "spacescape".* (ESPI, 2005)

Similarly, from the science community:

> *A higher level of coordination between ESA, EC and national agencies must be pursued in order to ensure a balanced, long term funding to data analysis activities, such that it can enable a faster and more efficient scientific exploitation of Earth observation data from space.* (ESSC, 2005)

5.2 Key Issues

5.2.1 Overview

This Report covers the institutional (defence and civil) and commercial markets. The prime role of ESA is in managing R&D programmes for the institutional civil market. It is, of course, recognised that some R&D programmes are intended to lead (ultimately) to commercial operations. It is further recognised that ESA accounts for the majority of the EU's institutional civil budget (see Table 2.2).

Although there are calls for closer EU/ESA cooperation, the development (and implementation) of a European Space Policy will need to account not only for the interests of ESA and the EU but also the interests of Member States and the commercial stakeholders. However, the focus of this part of the Report is on the ESA-EU relationship and how this may be taken forward. As such, the focus is very much on the management of the institutional civil market.

As outlined above, there are several issues associated with the current arrangements which merit further discussion, including:

- military use of space;
- involvement of non-EU countries; and
- resource allocation and utilisation.

5.2.2 Military Use of Space

Article II of the Convention (ESA, 2005) states:

> *The purpose of the Agency shall be to provide for and to promote, for exclusively peaceful purposes, cooperation among European States in space research and technology and their space applications, with a view to their being used for scientific purposes and for operational space applications systems.*

In the context of space (and related treaties, conventions and associated literature), the use of the word ‘peaceful’ is usually taken to mean ‘non-aggressive’. As such, there is a general consensus that the use of satellites for monitoring and surveillance in the interests of security is ‘peaceful’ and ‘non-aggressive’. However, the situation becomes less clear when considering the use of satellites in ‘network centric warfare’ in which satellites may be used for both surveillance and for target acquisition[67]. At this point, it is important to stress that, currently, defence activities (R&D, procurement, etc.) tend to be undertaken by national Governments rather than by the Council of the European Union or the European Defence Agency (EDA). Nevertheless, with the further development of the European Security and Defence Policy as well as actions by the EU and EDA to encourage European cooperation on R&D and trade issues, it is inevitable that defence issues (including space applications) will become more ‘European’ in nature.

Such issues have, of course, been explored before. For example, in a study funded by ESA, the Istituto Affari Internazionali (2003) argued that differentiating between ‘civil’ and ‘military’ space activities was largely artificial. As a consequence, EU involvement in space activities should be focused on integrating the demand side including defence and security aspects. Similar views were presented by Achache (2003), a former ESA Director of Earth Observation, who also notes that defence authorities are the largest customers for commercial imagery. To a large extent, such views were reflected in the Space White Paper (CEC, 2003a) which promoted the integration of space and defence. However, as noted above, subsequent authoritative documents make little or no reference to defence issues. Some consider that such a

[67] 68% of munitions were satellite guided in the 2004 Iraq war (UK Parliamentary Office of Science and Technology (2006): *Military Use of Space*, Postnote 273, dated December 2006).

state of affairs should not continue. For example, in a report for the European Parliament, Johnson (2006) summarises the situation as follows:

> *The nexus between the national defence policies of European countries, which are oriented towards military as well as civilian purposes, ESA, with its 'peaceful purposes' mandate, and the EU's role and competence in security and defence needs to openly addressed, clarified and managed, taking into account the dual use character of much of the technology and capabilities.*

This leads to the view that: *Without underestimating the political – especially transatlantic – sensitivities, Europe cannot afford to dodge these issues any longer.*

In relation to Galileo specifically, concerns have been expressed that the potential involvement of non-EU states in its commercial operation may lead to conflict with EU security and/or defence interests. As Valasek (2004) bleakly states:

> *But Galileo's dual existence - civilian in principle, military in potential - carries real risks. In the wrong hands, Galileo could become a weapon not only against US forces but also European ones.*

5.2.3 Membership Issues

The ESA-17 is not a sub-set of the EU-27. As such, Norway and Switzerland are members of ESA but not of the EU while the twelve countries which have most recently joined the EU are not members of ESA[68].

Clearly, greater influence of the EU in ESA activities could lead to problems for Norway and Switzerland. Furthermore, the influence of the major space countries may be reduced by those newer EU Member States which, as yet, have limited interest in space issues.

Of course these issues may also impact on the defence issues. Development of technologies which have potential dual-use (i.e. civil and military) under ESA programmes may conflict with EU export controls. Such issues are illustrated by the discussions surrounding the development of atomic clocks in Switzerland (assisted by the ESA Galileo programme) for export to China[69]. Furthermore, China and India have apparently expressed interest in being involved with the GNSS Supervisory Authority (to supervise the deployment and operation of the Galileo system). Nevertheless, it was the EU, working with ESA, which paved the way for China to become involved in the development of Galileo through the signing of a formal agreement in 2003[70].

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68 However, as already noted, four of these countries (Czech Republic, Hungary, Romania and Poland) have signed PECS agreements with ESA as a step towards full ESA membership.

69 *EU Likely to Bar China from Galileo Supervisory Authority*, Space News, 19 June 2006.

70 Council of the European Union (2003): **Cooperation Agreement on a Civil Global Navigation Satellite System (GNSS) – Galileo between the European Community and its Member States and the People's Republic of China**, Document 13324/03 as signed at the EU-China Summit in Beijing on 30 October 2003. Similar cooperation agreements have been signed with Israel (June 2005), Ukraine

5.2.4 Resource Allocation

Work on ESA programmes is allocated to ESA members in proportion to their financial contribution as set out in Article VII c) (and Annex V) of the ESA Convention (ESA, 2005). This approach is sometimes referred to as *juste retour* or *geo-return* (although such terms tend to be avoided in ESA documents).

On the other hand, the EU Competition Policy is intended to promote an open market economy throughout the EU. As such, activities by suppliers or purchasers (including national governments) which distort the market are governed by various rules and regulations.

In recognition of this, the European Interparliamentary Space Conference has, perhaps somewhat optimistically, called upon the Commission to relax competition policies in relation to space activities (EISC, 2004 and EISC, 2005).

Although there is a general presumption against state aid within the EU (under Article 87(1) of the EC Treaty), it is important to note that "aid granted by supranational and multinational organisations" (with specific reference to ESA) does not constitute 'state aid'[71]. More generally, where EU Member States wished to support their (civil) space activities through state funding, such aid might be considered 'compatible with the common market' according to various criteria set out in Article 87(3) including:

> *aid to facilitate the development of certain economic activities or of certain economic areas, where such aid does not adversely affect trading conditions to an extent contrary to the common interest.* Article 87(3)c of the EC Treaty[72].

The situation may, perhaps, have become more complex with a recent Commission notice[73] which sets out the conditions where state aid will be authorised by the Commission in respect of R&D&I (research and development and innovation)

The issue of resource allocation was discussed with key stakeholders. The general view was that the ESA approach has been an important factor in generating interest in space activities across a number of countries. However, it was recognised that such an approach has not always led to best value for money.

In relation to obtaining EC funding, stakeholders considered that the requirements for multinational consortia (under FP6 for example) could also be a complex and inefficient process. It is worth noting that, under FP7, although intra-EU consortia are

(December 2005) and Korea (October 2006)

71 Further detail on state aid and Article 87 is available from: ec.europa.eu/comm/competition/state_aid/overview/index_en.html

72 It is worth noting that some recent state interventions to support broadband development in particular areas of the EU have been permitted under Article 87(3)c.

73 **Community Framework for State Aid for Research and Development and Innovation**, Commission Notice 2006/C 3232/01 dated 30.12.2006.

still required, the Commission has taken on board some of the criticisms made of the FP6 procedures[74].

5.3 Management Models - Short Term

5.3.1 Options

As indicated in the Specifications, consideration is to be given to the following options by the EC:

- to externalise to ESA the management of some or all EU space-related activities;
- to participate in ESA optional programmes; or
- to establish further joint structures with ESA or with ESA together with Member States.

Such options should take account of the current ESA/EC Framework Agreement and of a possible renegotiation. Since all three options are covered by Article 5 of the existing ESA/EC Framework, their use, in principle, is not dependent on a renegotiated agreement. However, the degree and effectiveness of the future use of such options could depend on a renegotiated agreement.

5.3.2 Experience of Options to Date

EU Funding and ESA Management

There appears to be a general consensus that ESA has been very successful in assisting with the development of space technologies. Such development has been funded by ESA Members with, for some projects, assistance from the EU including, as outlined above, funding for EGNOS, Galileo and GMES. There will be further EU funding for Galileo and GMES as well as for space R&D projects under FP7.

With these points in mind, it would appear that externalising management of EU space-related activities to ESA has broadly been a success (at least at the development stage). Although there is little to suggest that such a situation could not continue into the future, there are reports (for example, eoVox, 2006) that FP6 funding for large projects has been slow and unwieldy (which echoes the views of stakeholders noted above) with the necessity to find not only co-workers from other countries but also other sources for match funding.

74 **Communication from the Commission responding to the Observations and Recommendations of the High-Level Panel of Independent Experts concerning the New Instruments of the 6th Framework Programme**, COM(2004) 574 final dated 27.08.2004. The panel was led by Professor Marimon and the 'Marimon Report' is available from www.econ.upf.edu/~marimon.

ESA Optional Programmes

Under the current ESA/EC framework, the EU could fund and directly participate in an optional ESA programme. To date, this option has not been used. No indication has been provided by the Commission (or stakeholders) that such an option would be pursued in the future. Nevertheless, this option may be worthy of further consideration as it seems to offer a ready-made means for the EU to fund space projects without establishing joint structures (discussed below). Furthermore, if the EU was the sole funder, then the ESA geo-return principle would allow work to be allocated amongst EU Member States according to EC rules.

Joint Structures

In relation to joint structures, experience to date has focused on EGNOS, Galileo and GMES. As such, these are effectively the mechanisms by which projects partially funded by the EU are managed by ESA. The view of many stakeholders is that there have been tensions between ESA and the Commission which have led to delays and difficulties in establishing joint structures. It should, however, be noted that there are few authoritative documents (as opposed to verbal comments and press reports) on which to base a thorough analysis.

As mentioned above, although EGNOS was successfully developed, there were delays and overspend. In relation to Galileo, the performance of the Galileo Joint Undertaking (GJU) has received a glowing evaluation (COWI, 2006) despite delays, a €400m overspend and failing to meet standard criteria for establishing the private-public partnership to operate Galileo in the longer term. Furthermore, it is apparent that there are continuing concerns over the ability of the prime contractor (European Satellite Navigation Industries - the new name for Galileo Industries) to complete the development stage of the project to time[75].

In relation to GMES, the potential future structure is under debate. Proposals have been put forward (GAC, 2006) for the current GMES Bureau (within DG Enterprise) to evolve into the GMES Management Authority reporting to a Council of the European Union (in much the same way as EU Agencies discussed in the next section). Interestingly, in response, GMES stakeholders (including downstream users) have requested a much broader representation on the future decision-making bodies (GAC, 2006a).

Summary

Although ESA/EC cooperation in the funding and management of space activities has resulted in major projects being taken forward, there appears to be a consensus that there is room for improvement.

[75] See, for example, *Galileo Industries told to put house in order*, on-line article www.gpsworld.com, dated 23 January 2007 and *Galileo Satellite Consortium*, on-line article www.thebusinessonline.com dated 24 January 2007.

As ESA itself notes, a major weakness of the current situation is that the:

> *governance scenario is not yet consolidated, with risks of sub-optimal management structures and insufficient coordination of partly diverging interests and priorities among Member States, ESA, EU and industry*. (ESA, 2006b)

5.3.3 Options for Analysis

The starting point for the analysis is the current situation in which ESA and EC cooperate under the Framework Agreement - supplemented, where appropriate, by individual agreements for particular actions. Although there are calls for change, there is no intrinsic reason why the current situation could not continue into the future. This is taken as **Option 1 - No Policy Change** in the analysis which follows.

In the short term, there are steps which might be taken to modify the ESA/EC working arrangements. Although various options were outlined in Section 5.3.1, there is insufficient evidence available on which these options can be separately developed into a meaningful basis for further analysis. Instead, a composite option (**Option 2 - Revised ESA/EC Framework**) for the short term is proposed. The key differences between Option 2 and Option 1 (baseline) are:

1. for ESA to align its work allocation rules more closely to those of the EC;
2. for ESA to increase its membership to include more EU Member States; and
3. for the EC to establish a 'Space Bureau' (similar to the GMES Bureau) within the Commission to provide a focal point for the Commission's space activities across different DGs.

It is of note that ESA is already moving towards the first two steps as part of its *Agenda 2011* (ESA, 2006a).

The key characteristics of the first two options are presented in Table 5.1 (with further commentary provided in Section 5.5).

Table 5.1: Characteristics of Options for the Short Term		
Instrument:	**Option 1: No Policy Change**	**Option 2: Revised ESA/EC Framework**
Current Examples (related to Space)		
	Existing ESA/EC Framework	**Similar to Existing ESA/EC Framework**
Nature of Instrument		
Location	Paris (ESA) & Brussels (EC)	Paris (ESA) & Brussels (EC)
Definition	Intergovernmental organisation (ESA) manages the majority of Europe's institutional civil space programme, in cooperation with EC where appropriate	
Governance		
	ESA is directed by its Council of Ministers (C-M) of the 17 Member States. ESA activities are undertaken in accordance with the ESA Convention, while those of the Commission (and EC more generally) are undertaken in accordance with EU rules. ESA/EC cooperation in accordance with existing Framework Agreement. Overall activities to be undertaken within the context of the forthcoming European Space Policy and Programme.	As Option 1, subject to any revisions to ESA Convention and ESA/EC Framework. Potential for Space Council to take a more active role.
Operations		
	ESA's programme is set out in Long-Term Plan while EU funded R&D is within FP7. Specific projects are managed by ESA under the guidance of its Director General. EC activities led by several DGs within the Commission. There are also other bodies with responsibilities for Galileo and GMES.	As Option 1 but with a centralised EC focus through a 'space bureau' (located within the Commission).
Finance		
	ESA annual income of €3bn (90% from Member States) expected to increase at 2.3%pa. Annual contribution (to ESA programmes) from EU expected to increase from around €100m to €400m by 2016 (mainly from FP7). Also €100m from Commission Energy & Transport budget line for Galileo in 2007[76].	Financing is likely to remain mainly 'programme-based' as for Option 1.
Note: Although ESA's headquarters are in Paris, there are a number of major facilities elsewhere including ESTEC (European Space Research and Technology Centre) in the Netherlands, ESOC (European Space Operations Centre) in Germany, ESRIN (ESA Centre for Earth Observation) in Italy, ESAC (European Space Astronomy Centre) in Spain, EAC (European Astronaut Centre) in Germany as well Europe's Spaceport in French Guiana (in South America).		

76 EC Budget dated February 2007.

5.4 Management Models - Longer Term

5.4.1 Introduction

There are various types of 'agency' which may be established within the European Union.

European Community Agencies

Community Agencies are set up by acts of secondary legislation to accomplish specific tasks within the framework of the EU's 'first pillar'. Community agencies are run by administrative boards which usually comprise representatives from the Commission and Member States. There are currently 21 such agencies (with a further two proposed[77]) including the European Food Safety Authority, the European Agency for Safety and Health at Work (OSHA) and the European Railway Agency.

European Union Agencies

Common Foreign and Security Policy Agencies are set up to carry out specific tasks within the framework of the Common Foreign and Security Policy (CFSP - the EU's 'second pillar'). There are three such agencies: European Defence Agency (EDA); European Union Institute for Security Studies (EUISS); and European Union Satellite Centre (EUSC).

Police and Judicial Cooperation in Criminal Matters Agencies are set up to cooperate against organised crime (the EU's 'third pillar'). There are three such agencies: The European Union's Judicial Cooperation Unit (Eurojust), European Police Office (Europol) and European Police College (CEPOL).

Agencies established under the second and third pillars report to the Council of the European Union (i.e. Member States).

Executive Agencies

There are also 'executive agencies' set up to undertake certain tasks relating to the management of one or more Community programmes. There are currently two executive agencies (Education, Audiovisual & Culture Executive Agency (EACEA) and Intelligent Energy Executive Agency (IEEA)) with at least five more proposed (Executive Agency for the Public Health Programmes, Executive Agency for trans-European (transport) Networks (TENs), Executive Agency for the Competitiveness and Innovation Framework Programme (CIP), European Research Council Executive Agency (ERC EA) and the FP7 Implementation Executive Agency (FP7 EA)).

[77] Outlines of EU agencies are available from europa.eu/scadplus/glossary/eu_agencies_en.htm and europa.eu/agencies/index_en.htm

5.4.2 Space-related Agencies within the EU Framework

ESA, of course, is not an agency within the EU framework as it is an intergovernmental organisation established outside of the framework of EU treaties. Nevertheless, there are currently three agencies (within the EU framework) of direct relevance to the European 'spacescape' with a further one proposed:

- *European Global Navigation Satellite System (GNSS) Supervisory Authority* is a Community Agency established by Council Regulation[78] and is one of the 21 agencies mentioned above. The Authority will be responsible for overseeing the deployment and operation of the Galileo and related programmes[79]. There will be an Administrative Board with one representative per Member State and one from the Commission. The Board will establish a System Safety and Security Committee with similar representation and may establish a Scientific and Technical Committee comprising experts nominated by Member States and the Commission. The Authority is provisionally located in Brussels pending a decision on its final location within a Member State;
- in 2004, the Council of the European Union established the *European Defence Agency* (EDA[80]) to improve European defence capabilities in the field of crisis management and to sustain the European Security and Defence Policy (ESDP). The EDA is a Common Foreign and Security Policy Agency involving all EU Member States (apart from Denmark). The EDA has a Steering Board comprising one representative (essentially the Defence Minister) from each Member State (except Denmark) which reports to the Council of the European Union. The EDA is based in Brussels;
- *European Union Satellite Centre* (EUSC) was established[81] in 2002 to process satellite imagery in support of CFSP and ESDP (European Security and Defence Policy). The EUSC is a Common Foreign and Security Policy Agency involving all EU Member States (although Denmark does not participate on matters with defence implications). The EUSC has a Board comprising one representative from each Member State and one from the Commission which reports to the Political and Security Committee of the Council. The EUSC is based in Torrejón, near Madrid; and
- *FP7 Implementation Executive Agency* (FP7 EA) has been proposed[82] to manage FP7 projects including 'Security and Space' actions over the period 2007-2017. The FP7 EA will be located in Brussels.

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78 **Council Regulation (EC) 1321/2004 on the Establishment of Structures for the Management of the European Satellite Radio-Navigation Programmes**, dated 12 July 2004.

79 The deployment and operation of the Galileo satellites will be undertaken by the Galileo Operating Company (the Galileo Concessionaire appointed under a Public-Private Partnership).

80 **Council Joint Action 2004/551/CFSP on the Establishment of the European Defence Agency**, dated 12 July 2004.

81 **Council Joint Action 2001/555/CFSP on the Establishment of a European Union Satellite Agency**, dated 20 July 2001.

82 Paper entitled *Implementing FP7 Practicalities and Procedures*, presented by G Stroud (DG Research) at SwissCore Seminar held in Brussels on 23/24 November 2006.

5.4.3 Potential Agencies within the EU Framework

In the longer term, it is possible that ESA could evolve into some form of agency within the EU framework. Since agencies have been established on a case by case basis, there is some uncertainty as to the general characteristics of different types of agencies - although those for 'executive agencies' are clearly stated in a 2002 Council Regulation[83]. For most of the other agencies, the Commission uses the term 'regulatory agencies' and the word 'regulatory' in a very broad sense[84].

In 2005, the Commission issued a draft Interinstitutional Agreement on Regulatory Agencies[85] which the Consultants have been advised that, once adopted, would apply, initially at least, to all new agencies established under the first pillar (i.e. to new Community Agencies). The draft agreement states:

> *An agency may be entrusted with one or more of the following tasks:*
>
> *a) applying Community standards to specific cases. To this end, the agency shall be given the power to adopt individual decisions which are legally binding on third parties;*
> *b) providing direct assistance to the Commission and, where necessary, to the Member States in the interests of the Community, in the form of technical or scientific opinions and/or inspection reports;*
> *c) creating a network of national competent authorities and organising cooperation between them in the interests of the Community with a view to gathering, exchanging and comparing information and good practice.*

Clearly, tasks b) and c) could be applied directly to an agency responsible for the 'evolution of space in Europe' established under the first pillar - which has been taken as **Option 3 - European Community Agency** (i.e. the same type of agency as the GNSS Supervisory Authority). Should such an agreement (or similar agreement) be extended to cover agencies under the second pillar then an agency responsible for the 'evolution of space in Europe' could be established under the second pillar (hence **Option 4 - European Union (CSFP) Agency**). It is envisaged that such an EC or EU Agency would evolve from the current ESA/EC arrangements.

The essential difference between Options 3 and 4 is the role of defence and security aspects. Under Option 3, the focus of the EC Agency would be on civil uses of space (science, Earth observation, communications, etc.) and, as such, would have a similar focus to that of ESA at present. Under Option 4, the focus of the EU Agency would

83 **Council Regulation (EC) 58/2003 laying down the Statute for Executive Agencies to be entrusted with Certain Tasks in the Management of Community Programmes**, dated 19 December 2002.

84 **Commission Communication - The Operating Framework for the European Regulatory Agencies**, COM(2002)718 final dated 11.12.2002.

85 **Draft Interinstitutional Agreement on the Operating Framework for the European Regulatory Agencies**, COM(2005)59 final presented by the Commission and dated 25.02.2005 (which supersedes COM(2002)718 final referenced above). The Consultants have been advised that this Agreement, once adopted, would apply, initially at least, to new agencies established under the first pillar.

be on the full range of EU space activities, overtly encompassing dual-use applications. This, of course, does not preclude an EU Agency undertaking non-military activities in the same way as for the European Union Satellite Centre which processes satellite images for military and civil use (as discussed above in 5.4.2). Similarly, the European Defence Agency is intending to fund 'science' projects (although with potential long-term military or dual-use application).

For completeness, consideration has also been given to the evolution of **Option 5 - Executive Agency** since it is possible that space (at some point in the future) could form a Community programme in its own right. A brief overview of the characteristics of each type of agency is presented in Table 5.2 (overleaf) with further commentary provided in Section 5.5.

Strictly speaking, it should not be possible to create one of the above agencies for an activity which is outside the framework of the EC Treaty. Since 'space' forms part of the new and, as yet, unratified Constitution, such limitations may apply. However, such constraints could perhaps be overcome by invoking Article 308 of the Treaty[86] which states:

> *If action by the Community should prove necessary to attain, in the course of the operation of the common market, one of the objectives of the Community and this Treaty has not provided the necessary powers, the Council shall, acting unanimously on a proposal from the Commission and after consulting the European Parliament, take the appropriate measures.*

[86] Although defence also forms part of the unratified Constitution, the establishment of the European Defence Agency was not dependent on Article 308. However, the evolution of the European Monitoring Centre on Racism and Xenophobia (EUMC - one of the EC Agencies) into the Fundamental Rights Agency (an EU Agency under the 3rd pillar) on 1st March 2007 relied on Article 308 (**Council Regulation (EC) No 168/2007 establishing a European Union Agency for Fundamental Rights**, dated 15 February 2007).

Table 5.2: Characteristics of Options for the Longer Term			
Instrument:	**Option 3: European Community Agency (Agency under 1st Pillar)**	**Option 4: European Union Agency (Agency under 2nd Pillar)**	**Option 5: Executive Agency**
Current Examples (related to Space)			
	GNSS Supervisory Authority	**EDA, EUSC**	**FP7 EA (proposed)**
Overview			
Location	Although, in general, future EC/EU agencies are likely to be located in 'new' Member States, it would clearly be sensible for a Space Agency to have its headquarters located in Paris as at present.		Brussels (mandatory)
Definition	As for other agencies, a Space Agency would provide a focus for co-operation and good practice as well as assisting the Commission and Member States. However, it would have a much greater operational role than other agencies.		The Commission may decide, after a prior cost-benefit analysis, to set up a Space Executive Agency to manage a (future) Community space programme. The lifetime of the Agency will (normally) be that of the programme. The development of the programme and associated policy issues would be the responsibility of a 'space bureau' within the Commission.
Governance			
	For existing agencies, there is an administrative board with representation from Member States and the Commission. In some cases, the representation is much wider. For example, OSHA has a Governing Board which comprises representatives from EU Member States, employers and workers as well as representatives of the Commission. However, a key aspect of the draft interinstitutional agreement is that the administrative board of a new agency would have equal representation (voting rights) of Member States and Commission - although, in practice, it is likely that Member States would have more than 50% of the voting rights.	As for Community Agencies under the first pillar, there is an administrative board. However, it is of note that the EDA does not have Commission representation on its board. Also the activities under the CSFP may have a less 'public' audience. For example, the EUSC reports to the Political and Security Committee. Given the importance of Member States in relation to activities under the second (and third) pillars, it is unlikely that equal representation of the Commission and Member States for new agencies would be proposed for the administrative board of an EU Agency.	When adopting a Community programme, the Commission must inform the budgetary authority of whether it intends to set up an Executive Agency to implement the programme. An Executive Agency is managed by a Steering Committee and a director. The Steering Committee consists of five members appointed by the Commission.

<table>
<tr><th colspan="4">Table 5.2: Characteristics of Options for the Longer Term</th></tr>
<tr><th>Instrument:</th><th>Option 3: European Community Agency
(Agency under 1st Pillar)</th><th>Option 4: European Union Agency
(Agency under 2nd Pillar)</th><th>Option 5: Executive Agency</th></tr>
<tr><td colspan="4">Operations</td></tr>
<tr><td></td><td colspan="2">A Director will assume full responsibility for the operational tasks assigned to the Agency and will be the Agency’s legal representative. Scientific committee(s) and/or committee(s) of experts and board(s) of appeal can be set up to aid the Agency to operate effectively.

The Staff Regulations of officials of the European Communities, the Conditions of Employment of other servants of the European Communities and the rules adopted jointly by the European Community institutions for the purpose of applying these staff regulations and conditions of employment shall apply to the staff of the agency.

As well as requiring the resources required to operate the services, an agency would also need to cover all of its own horizontal services such as human resources, accountability, etc. in a way that would mirror the Commission.

Note: It has been assumed that the operation of new agencies under the 1st pillar as envisaged by COM(2005)59 would be followed by agencies established under the 2nd pillar</td><td>An Executive Agency's director has authority over its staff. Staff may be seconded Community officials or directly recruited. The nature of the contract, governed by either private law or public law, its duration and the extent of the servants' obligations vis-à-vis the agency, and the appropriate eligibility criteria shall be determined on the basis of the specific nature of the tasks to be performed, and shall comply with the Staff Regulations as well as with current national legislation.

As well as requiring the resources required to operate the services, an Executive Agency would also need to cover all of its own horizontal services (as for Community/Union Agencies).</td></tr>
<tr><td colspan="4">Finance</td></tr>
<tr><td></td><td>For a Community Agency under the 1st pillar, it is likely that it would be financed through a subsidy from the general budget of the European Communities.

The Commission proposes to the budgetary authority each year the amount of the subsidy for the agency and the number of staff it considers the agency needs, on the basis of the estimate of expenditure and revenue drawn up by the administrative board.

Each agency must adopt its financial rules. Where it is in receipt of a Community subsidy, it must follow selected EC regulations. The Commission's internal auditor shall exercise the same powers over the agency in receipt of a Community subsidy as he does in respect of the Commission.</td><td>For an EU Agency under the 2nd pillar, it is likely that it would be financed through contributions from Member States (it is worth noting that the basic act may make provision for a contribution from non-Community countries taking part in the agency’s work).

It may be possible that such payments could be supplemented by a subsidy from the Community in which case it is likely that the same rules described for a 1st pillar agency would apply.</td><td>Funded from programme appropriations under Operational Appropriations in the Commission budget, funding is linked to the programme that the agency is established to manage. In this sense, the life of an Executive Agency is time-limited by the length of the programme it is set up to implement.

The standard financial regulation applicable to the operating budget of an Executive Agency shall be adopted by the Commission. That standard regulation may deviate from the Financial Regulation applicable to the general budget of the European Communities only if the specific operating requirements of the executive agencies so require.</td></tr>
</table>

5.5 Summary of Options

5.5.1 Introduction

The analysis presented in this section focuses on the potential evolution of the existing ESA/EC Framework with consideration being given to options in both the short and longer term. As such, the focus of the analysis is on the administrative structure which is responsible for managing most of Europe's institutional civil expenditure on space activities. Although particular structures may provide additional benefits for commercial or defence related space activities, these are not the prime focus of the analysis. However, the degree to which a particular option may be preferred in the longer term will depend, in part, on how issues relating to defence and security are to be tackled.

In order to provide a basis for comparison, there are five underlying assumptions which apply to all the options:

1. the overall budget for institutional civil space activities (primarily ESA and EC funds) remains the same (although the relative contributions may change);
2. both EC and ESA would support the option under consideration and undertake the necessary tasks to bring it about;
3. most ESA staff would continue to work on projects as at present;
4. ESA's operational centres would continue as at present with the headquarters remaining in Paris (except in the case of an Executive Agency where the headquarters would need to be relocated to Brussels); and
5. where possible, co-operation with non-EU countries would continue (although some existing ESA agreements may need to be redrawn).

5.5.2 Option 1 - No Policy Change

This option represents the baseline with no significant changes from the current situation in which most of the European institutional civil space activities are funded through, and managed by, ESA. Although most funds come directly from ESA Member States, there are some EC funds. There is ESA/EC cooperation in accordance with the current ESA/EC Framework Agreement.

5.5.3 Option 2 - Revised ESA/EC Framework

Option 2 has been taken to represent a possible evolution of the existing framework in line with ESA's *Agenda 2011* and the Commission's *Communication on European Space Policy* from 2005. As such, most institutional civil space activities will continue to be run by ESA based in Paris with cooperation from the EC.

However, some steps are taken to increase European participation (by increasing ESA membership) and efficiency (by providing a focal point, the Space Bureau, within the Commission for coordinating EC space activities). In addition, it is anticipated that the Space Council would take a more active role in promoting pan-European activities.

It is also proposed that consideration be given to aligning ESA policies for work allocation more closely to the principles of EU competition policy. An example of a less rigid geo-return basis for work allocation has been adopted by the EDA in which, if required, projects are awarded on the basis of votes which are weighted according to the relative contributions of Member States to the overall programme budget[87].

5.5.4 Option 3 - European Community Agency

In the longer term, it would be possible to establish a Community Agency under the first pillar. This assumes that the necessary steps have been taken to enable such an agency to be established under the terms of the EC Treaty and with agreement, in principle, between ESA and the EC. Even where the decision has been made to proceed to establish a Community Agency, the associated legal and administrative processes may take three years or more to complete[88]. Although the role of non-EU ESA Member States (Switzerland and Norway) would be diminished, they would still be able to participate in the activities of a Community Agency[89]. More generally, co-operation with third countries (through further agreements) would be encouraged[90].

The overall direction of the Community Agency would be the joint responsibility of Member States and the Commission (as represented on the Administrative Board). The focus of the activities of a Community Agency would be on civil projects and, as such, should not lead to substantial changes in the nature of the work undertaken. However, it would be expected that one area of potential change would be that projects would be awarded to contractors on the basis of rules and procedures more closely aligned to those of the EU.

The Community Agency would be funded from a Commission budget line (renewed annually). As such, the relative contributions from Member States would depend on their overall contributions to the EC and would be different from the relative contributions made to ESA.

5.5.5 Option 4 - European Union (CSFP) Agency

In the longer term, it would be possible to establish an EU Agency under the second pillar. As for Option 3, this would be a complex and lengthy procedure and the role of non-EU ESA Member States (Switzerland and Norway) would be diminished, although co-operation with non-EU countries would continue to be encouraged.

The overall direction of the EU Agency would be the responsibility of Member States. The focus of the activities of an EU Agency would span all space activities including

87 European Defence Agency (2006): *Background on Defence R&T Joint Investments Programme on Force Protection*, note dated 13 November 2006.

88 As advised by the Secretariat-General of the European Commission.

89 For comparison, non-EU Member States (including Norway and Switzerland) will participate in the second generation Schengen Information System (SIS II) which will be run by an EU Agency (under the third pillar).

90 As an example, the European Aviation Safety Agency (an existing EC Agency) has established formal working arrangements with numerous non-EU countries (www.easa.eu.int/home/intl_appro_en.html)

projects with (potential) dual use applications. This would lead to changes in the emphasis of the work undertaken but would not necessarily requires changes in the staff undertaking technical and administrative duties. It would be expected that work allocation rules would be determined by Member States (through the Administrative Board). Although a move towards EU rules and procedures might be expected, it would still be possible to retain elements of geo-return (as illustrated by the EDA example provided above).

The EU Agency would be funded from (EU/ESA) Member States (and reviewed annually). As such, the relative contributions from Member States would be subject to negotiation. For existing ESA Member States, it is possible that the relative contributions to an EU Agency could be similar to the relative contributions currently made to ESA.

5.5.6 Option 5 - Executive Agency

The establishment of an Executive Agency represents the greatest change from Option 1 and would (effectively) move the responsibility for European space activities to the Commission. As before, this would be a complex and lengthy procedure (although less so than for Options 3 and 4,). However, it would be difficult to involve non-EU ESA Member States (Switzerland and Norway) in the activities of an Executive Agency. Furthermore, under the current Regulations, an Executive Agency would be located in Brussels.

The Executive Agency would be responsible for implementing the ‘space’ programme. Clearly, activities relating to selecting contractors, project management, etc. are routinely carried out by ESA and it would be hoped that appropriate staff could be relocated from Paris to Brussels. However, one area of significant change would be that projects would be awarded to contractors on the basis of EU rules and procedures.

There would also be a need to establish a focal point within the Commission (in Brussels) to first develop the programme for implementation by the Executive Agency. Again, it would be hoped that appropriate ESA headquarters staff could be relocated from Paris to, perhaps, a larger version of the Space Bureau envisaged for Option 2. This Space Bureau would also be responsible for ‘space’ policy issues.

The Executive Agency (and its activities) would be funded from a Community ‘space’ programme budget (which would typically be over a five year period). As such, the relative contributions from Member States would depend on their overall contributions to the EC and would be different from the relative contributions made to ESA. Of course, particular projects could be jointly funded between a Community programme and contributions from other sources (which could include non-EU Member States[91]).

[91] For example under FP7, an ‘associated country’ (i.e. a non-EU country) which is party to an international agreement with the EC can contribute to, and participate in, FP7 projects.

5.6 Assessment Criteria and Commentary

5.6.1 Overview

The criteria for determining the relative performance of different models (options) were reviewed by the Study Team and some revisions made to those set out in the Specification/Proposal. The revised and extended set of criteria/objectives were discussed and agreed (with minor amendments) at the Steering Committee meeting held in November 2006. The agreed set of criteria is the extent to which an option will be able:

- to contribute to European cohesion;
- to contribute to the position of Europe on the world space scene;
- to strengthen Europe's space and technological capabilities;
- to maximise Europe's market access to the rest of the world;
- to improve the competitiveness of the European space industry;
- to enable the implementation of demand-driven space programmes;
- to improve the efficient use of resources for space in Europe;
- to encompass or accommodate the production of dual use (e.g. civil and defence) applications; and
- to maximise, to the extent possible, the institutional coherence.

It is acknowledged that the precise meaning of each criterion/objective is open to a degree of debate. With this in mind, each criterion has been divided into three sub-criteria to provide a more transparent basis for the subsequent comparison of options. The criteria and associated sub-criteria are outlined below - together with some comments on their applicability to the various options under consideration to provide an introduction to the more comprehensive comparison of options presented in Section 5.7.

5.6.2 European Cohesion

The Community Strategic Guidelines on Cohesion 2007-2013[92] identify the following aims, which are consistent with the Lisbon Strategy:

- *improving the attractiveness of Member States, regions and cities by improving accessibility, ensuring adequate quality and level of services, and preserving their environmental potential;*
- *encouraging innovation, entrepreneurship and the growth of the knowledge economy by research and innovation capacities, including new information and communication technologies; and*

[92] **Commission Communication - Cohesion Policy in Support of Growth and Jobs: Community Strategic Guidelines, 2007-13**, COM(2005)0299 dated 05.07.2005.

- *creating more and better jobs by attracting more people into employment, entrepreneurial activity, improving adaptability of workers and enterprises and increasing investment in human capital.*

European cohesion can also be taken to refer to increasing coherence amongst EU Member States (now the EU-27). On this basis, increasing access to space activities for those EU Member States which are not currently members of ESA would contribute to European cohesion. Of course, it could also be argued that reducing the role of Switzerland and Norway (as non-EU ESA Members), under some options, could reduce European (as opposed to EU) cohesion.

ESA's views are more centred on ensuring coherence of scientific and technical endeavour. By way of example, ESA (2006b) identifies that a major opportunity is to increase the *complimentarity between ESA, other intergovernmental, EU and national activities, moving towards a coherent approach in support of the European space programme by taking into account available competencies, capacities and activities*.

In addition, ESA's Strategic Guidelines (as listed in ESA, 2006b) include:

> *enhance coherence in the development and growth of all European space capacities, ensuring coherence between launcher and other spacecraft development, as well as between technology and user-programme development, taking advantage of opportunities arising from combining space-related capabilities and competencies in the European space sector*.

Therefore, there are a number of ways of interpreting the criterion 'to contribute to European cohesion'. The sub-criteria adopted in this analysis were:

- to increase access to space activities for those EU Member States which are not currently members of ESA;
- to ensure coherence among European space development activities; and
- to combine space-related capabilities and competencies in the European space sector.

Assessing the options (relative to the baseline Option 1 - No Policy Change) against these interpretations involves varying degrees of subjectivity. Whilst the first may be relatively easy to assess, the other issues are perhaps more difficult. Nevertheless, all the options have been developed with the intention of bringing the activities of ESA and the EU closer together and, as such, this would be expected to lead to increased coordination and coherence.

5.6.3 Europe on the World Space Scene

ESA has ensured that Europe has a major role in space activities and has established links with all the leading space powers. ESA (2006b) suggests that excelling in space science and discovery enhances Europe's *global influence on the world scene*. Such activities also *maintain balance in international relations, in particular by attracting non-European partners to cooperate on European initiatives* (subject, of course, to appropriate safeguards).

However, several consultees suggested that there was a need for a unified European 'voice' for space in international negotiations - particularly in relation to commercial activities.

The sub-criteria adopted in this analysis for contributing to the position of Europe on the world space scene were:

- to excel at science and discovery;
- to cooperate with non-European partners; and
- to facilitate a unified European 'voice'.

Given that there is a consensus that ESA has excelled at science and discovery, it is unlikely that any of the options for change will provide any advantage with respect to this sub-criterion. Although ESA would be keen to cooperate with non-European partners under Option 2 (Revised ESA/EC Framework), it is perhaps less likely that a Community or EU Agency (under Options 3 and 4) would pursue non-European partners to the same extent - and this would also apply to an Executive Agency (Option 5). In relation to providing a unified European 'voice', such a role could be undertaken by the Commission working with ESA (in Option 2) or by the Director of some form of Agency (Options 3 and 4). Under Option 5 (Executive Agency), this role would be undertaken by the 'space bureau' within the Commission.

5.6.4 Europe's Space and Technological Capabilities

Strengthening space and technological capabilities will depend on investment, with particular regard to R&D. A strength of the current situation is Europe's recognised scientific and technological maturity. ESA (2006b) suggests that remaining at the forefront of space science and will ensure that, *inter alia*, highly-skilled European scientific and technical personnel are retained. The White Paper (CEC, 2003a) notes that in order to strengthen industrial performance, R&D and technological innovation should be increased. It is important to emphasise that apart from the 'science' R&D programmes, ESA currently manages extensive industrial R&D optional programmes (including, for example, ARTES and GSTP[93]). With this in mind, the successes of space R&D (currently) depend not only on ESA (and the EC) but also the national agencies and industry which drive ESA's optional programmes.

[93] Advanced Research in Telecommunications Systems and General Support Technology Programme respectively.

Given the range of organisations involved in space activities, ESA has recognised the need to take steps to improve R&D coordination with particular regard to '*filling of strategic gaps*' and the '*minimising of unnecessary duplication*'. This led to the European Space Technology Harmonisation effort which commenced in 2001 and the development of the European Space Technology Master Plan (ESTMP) which has been updated annually from 2002 (ESA, 2006).

The sub-criteria adopted in this analysis for strengthening Europe's space and technological capabilities were:

- to increase R&D and technological innovation;
- to strengthen the European scientific/technical skill-base; and
- to facilitate the exploitation of R&D.

Given that there is a general consensus that ESA excels in space R&D projects, it is unlikely that an evolution of the institutional arrangements (under any option) will enhance R&D and the skill-base (on the general assumption that the overall level of funding will remain the same) - particularly given current efforts to ensure coherent R&D. Indeed, it could be argued that under Option 5 (Executive Agency), the potential for innovation may be reduced as projects will be undertaken against a pre-defined programme (limiting the potential for adaptation) and the skill-base may be reduced due to loss of ESA staff if relocated to Brussels.

However, a key to further growth in space activities will be the successful exploitation of R&D. As such, the ESTMP (or similar plan) must be broad-based to ensure that the full range of potential applications are considered. It could be argued that under Option 3 (Community Agency) and, to a lesser extent, Option 2 (Revised ESA/EC framework), there is more potential to match the R&D work with the demands of downstream users (across the different DGs of the Commission) thus enhancing the potential for R&D exploitation.

5.6.5 Market Access

Europe's access to space markets in the rest of the world can be hampered by trade barriers (as discussed further in Section 3). As for 'Europe on the World Space Scene' (see above), the presence of a unified European voice (with designated authority) would strengthen Europe's negotiating position (for example in relation to WTO).

The sub-criteria adopted in this analysis for maximising Europe's market access to the rest of the world were:

- to increase development of European independence for critical capabilities, components and technologies;
- to strengthen Europe's position in international negotiations; and
- to maintain international relations.

Efforts are already underway to increase European independence (see Section 3.2.3) and it is perhaps unlikely that the situation would be improved under the various options. As indicated above, it is likely that when compared to Options 1 (No Policy Change) and 2 (Revised ESA/EC Framework), the focus of the Agencies (Options 3 to 5) would be on the EU. As such, greater efforts would be made to enhance market access for EU companies both inside and outside the EU. However, under Options 3 to 5, there may well be less emphasis on maintaining international relations through partnering non-EU countries.

5.6.6 Competitiveness of the European Space Industry

Improving the competitiveness of the European space industry is an aim frequently stated by the Commission and ESA. Defining what this entails is more difficult. Where trade barriers exist for entry into overseas markets, improving the competitiveness of the European space industry in those markets could include activities to reduce those trade barriers. Nevertheless, as these activities are discussed in the context of the improving market access criterion above, they are not included as part of this criterion. The sub-criteria adopted in this analysis for competitiveness were:

- to enable European companies to compete successfully in the world market;
- to allow European companies to compete for projects within Europe; and
- to provide a suitable regulatory environment in which to compete.

Although European companies do compete in the world market and will continue to do so, many do not as they are more focused on national and/or ESA work. As discussed earlier, under the ESA Convention (which would apply to Option 1), work is allocated according to the contributions of ESA Member States. The relaxation of these rules (under the other options) is likely to improve competition for these projects (the second of the above criteria). The intensity with which European companies compete for European projects may also improve their ability to compete on world markets.

However, the creation of a suitable regulatory environment will require the involvement of the EU (under Options 3 to 5). However, although the EU Competition Policy may lead to ‘open’ competitions, there may still be room for Member State interests to be taken into account (particularly under Option 4) on grounds of defence-related uses or for state aid (as discussed in Section 5.2.4). Finally, it is worth noting that the Council of the European Union supports increased institutional consolidation (discussed further below) as a means to improve competitiveness in the European space industry[94].

[94] **Council Conclusion of 27 November 2003 on the Contribution of Industrial Policy to European Competitiveness**, OJ C317/2 dated 30.12.2003.

5.6.7 Demand-driven Space Programmes

As has already been noted, ESA excels at R&D. However, improving the implementation of programmes requires a structure which is responsive to the (changing) needs of the downstream user. The general view of consultees was that the Commission was perhaps better placed to do this - although its response time was not always swift.

The EC's 2000 Communication on space[95] included the objective of

> *reaping the benefits for markets and society through a demand-driven exploitation of the technical capabilities of the space community. This requires the involvement of end-users from the planning phase until operational deployment in a constructive dialogue between all parties concerned from the public and the private sector, at the national and at the European level.*

In discussions on the Green Paper, an industry representative[96] presented views on the reform of the space industry, emphasising that the space industry had to become more demand-driven and user-oriented rather than staying reliant on institutional and Member States' funding. Under a market-based rationale for establishing programmes, the user community, and not the R&D interests, would have budgetary responsibility. This, it was argued, would increase the economic rationality of space investments, ensure a higher level of return to citizen-oriented applications, and dispense with the need for potentially market-distorting mechanisms.

A specific objective of ESA (2006b) is to:

> *promote and extend the utilisation of space-based infrastructures and services in current and new application domains* ***through a demand-driven approach****, in order to enlarge the market served by space technology… thus ensuring the availability, reliability and upgrading of the space-based services and integrated applications required to achieve Europe's overall objectives and improve the daily life of its citizens*.

ESA (2006b) is also concerned that the general public has a limited perception of the significance of space for improving quality of life.

The sub-criteria adopted in this analysis for enabling the implementation of demand-driven space programmes were:

- to increase awareness of the opportunities provided by space;
- to better coordinate requirements of users; and
- to be responsive to the requirements and views of downstream users.

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95 **Commission Communication - Europe and Space: Turning to a new Chapter**, COM(2000) 597 final, dated 27.09.2000.

96 Notes on the Third European Space Policy Workshop held in Leuven, Belgium, September 2003 and available from www.eurospacepolicy.org/report3.htm.

There is a general consensus that ESA has an R&D focus. As such, it is likely that Options 3 to 5 would provide greater opportunities for promoting space to EU citizens and businesses as well as for coordinating user requirements particularly in the public sector (where this could include consolidated institutional demand). These coordination requirements could also be met by the EC Space Bureau envisaged under the revised ESA/EC Framework (Option 2). However, it is unlikely that Executive Agency (Option 5) would be responsive in the short-term (in comparison to other options) since it would be implementing a pre-defined programme.

5.6.8 Efficient Use of Resources for Space in Europe

Improving the efficient use of resources requires coordination, maximising benefit opportunities, avoidance of duplication of effort, etc.

Although, as discussed in Section 5.6.4 above, ESA (in cooperation with others) has taken steps to improve the efficient use of resources, ESA acknowledges that more is needed. ESA (2006b) identifies a need to create an inclusive European architecture of space activities based on the network of competences, shared use of European facilities as well as coherent conducting of basic research and technology demonstration and the preparation of future application programmes. At present (and despite the ESTMP), ESA (2006b) notes that there is an:

> *absence of an overall roadmap of coordination among all European stakeholders and subsequent sub-optimal exploitation of overall available financial resources and capacities due to insufficient specialisation and characterisation of European and national centres*.

The sub-criteria adopted in this analysis for improving the efficient use of resources for space in Europe were:

- to improve coordination and reduce duplication of R&D effort;
- to increase specialisation and characterisation (to reduce duplication of resources and/or expertise); and
- to provide an overall coherent space strategy.

It is perhaps unlikely that any of the options would lead to a significant increase in ‘specialisation and characterisation’ in comparison to the baseline (Option 1). However, a centralised Agency (under Options 3 to 5) may be able to provide for improved coordination and, potentially, less duplication. However, such activities will be within the context of the evolving European Space Policy and Programme (see Section 5.1.3) which will be developed whatever the option followed.

5.6.9 Dual-use Applications

Traditionally, defence issues are dealt with by Member States. However, as discussed above, some space activities supported by ESA and the EC have the potential for dual use. Within the current situation, ESA (2006b) notes that there is a limited political consensus on, and low investment in, Europe-wide security and dual-use applications.

The sub-criteria adopted in this analysis for encompassing or accommodating the production of dual-use (e.g. civil and defence) applications were:

- to be mandated to develop defence-related applications;
- to increase the political consensus on Europe-wide security and dual-use applications; and
- to increase R&D activities in areas with potential for dual-use applications.

Of the options being considered, this aspect would clearly be best dealt with by the establishment of an EU Agency under the 2nd pillar (Option 4). In contrast, it is possible that a Community Agency under the 1st pillar (Option 3) or an Executive Agency (Option 5) would not have the mandate to be involved in matters which were potentially defence-related.

5.6.10 Institutional Coherence

A key feature of institutional coherence has been taken as minimising the degree of change from the existing ESA/EC structures. The (relative) closeness of each option to the Commission and to EU Member States is shown in Figure 5.1.

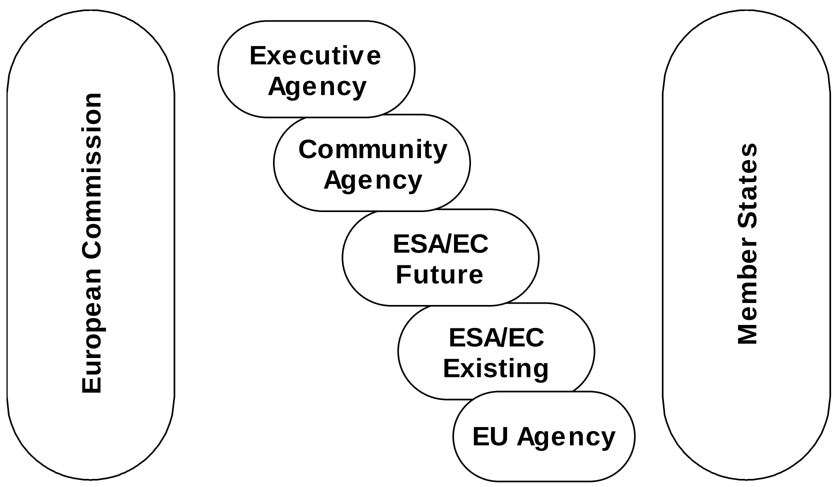

Figure 5.1: Closeness of Options to Commission and Member States

The sub-criteria adopted in this analysis for maximising, to the extent possible, the institutional coherence were:

- to minimise the level of risk/complexity involved in transitioning to each option;
- to minimise the degree of change from existing arrangements; and
- to have the ability to involve existing ESA (non-EU) partners.

As discussed previously, establishing a Community or EU Agency (Options 3 and 4) is particularly complex and time-consuming in procedural terms. Figure 5.1 illustrates that evolving from existing ESA/EC arrangements (Option 1) either to an EU Agency (Option 4) or to revised ESA/EC arrangements (Option 2) is likely to involve only a slight shift in position. However, a move to an Executive Agency (Option 5 - which is remote from Member States) would require a major shift in position which would be likely to lead to a loss of coherence.

Furthermore, an evolution to any of the 'agencies' (Options 3 to 5) would also create difficulties for the non-EU members of ESA (Norway and Switzerland) since their influence would be reduced within an EU framework. This, in turn, would lead to a loss of coherence.

5.7 Comparison of Options

5.7.1 Basis for Comparison

The comparison of possible future options against criteria involves a degree of uncertainty. This uncertainty can be minimised by ensuring that the analysis is transparent, reproducible and robust (European Commission, 2005).

With this in mind, sub-criteria have been developed to assist in clarifying how each of the main criteria can be considered when rating the potential performance of the different options. Furthermore, brief commentaries on each of the criteria (and associated sub-criteria) and on each of the options (and associated assumptions) have been presented in the previous sub-sections to provide an introduction to the comparison presented below.

The ratings presented below for the various sub-criteria under each option have been based on the analysis of documentation (as outlined in previous sections) and the views of stakeholders[97] and of the multi-disciplinary team undertaking the study, as well as those of the Steering Committee. Furthermore, as outlined below, a simple rating system has been used (thus avoiding debates over scoring on multi-point scales). As such, the analysis should be reproducible (to a considerable extent).

[97] It is important to stress that although stakeholders were not asked to compare the merits of various types of agencies, they were asked about, for example, the competitiveness of the space industry, their experiences of R&D work with ESA and the Commission and the roles of the Commission and other bodies in international negotiations.

On the basis that the analysis is considered transparent and reproducible within the context of (largely) pre-defined options and criteria (as originally set out in the Specifications), it is unlikely that adopting a different approach (but the same options and criteria) would lead to a substantially different outcome. As such, the analysis is considered robust subject, of course, to the validity of some of the assumptions made. By way of example, it is possible that some of future EC/EU Agencies may be structured differently from that assumed in this analysis. Similarly, as a basis for comparison, it has been assumed that the total budgets would be the same across the various options.

5.7.2 Assessment of Options

Each sub-criterion was assessed for the various management models using the simple rating system shown in Table 5.3.

Table 5.3: Impact Assessment Rating System

Rating	Meaning (relative to Option 1: No Policy Change)
-	Option likely to result in a negative impact
0	No change from Option 1
+	Option likely to result in a positive impact

As indicated above, it is possible that different management models would emerge as the preferred option under the various demand scenarios. It is important to stress that this would be reflected in the relative importance (i.e. weighting) of the various criteria (and associated sub-criteria) rather than the impacts assigned to each criterion. In other words, the impacts associated with each criterion for each management model would remain the same under each demand scenario but the weighted impacts would vary.

The assessment of the options (relative to Option 1: No Policy Change) against each of the sub-criteria is presented in Table 5.4 (overleaf).

Table 5.4: Potential Positive (+ve) and Negative (-ve) Impacts associated with Moving from Option 1: No Policy Change					
Criterion	**Option 2: Revised ESA/EC Framework**	**Option 3: Community Agency (under 1st Pillar)**	**Option 4: EU Agency (under 2nd Pillar)**	**Option 5: Executive Agency**	**Comment**
To contribute to European cohesion					
to increase access to space activities for those EU Member States which are not currently members of ESA	+	+	+	+	All options should lead to increased EU participation
to ensure coherence among European space development activities	+	+	+	+	All options should lead to increased coherence
to combine space-related capabilities and competencies in the European space sector	0	+	+	+	Options 3 to 5 provide integration into single institution
To contribute to the position of Europe on the world space scene					
to excel at science and discovery	0	0	0	0	Options unlikely to surpass ESA's record on science and discovery
to cooperate with non-European partners	0	-	-	-	Although ESA will continue to pursue non-European partners (Option 2), Options 3 to 5 likely to focus more on intra-EU cooperation
to facilitate a unified European 'voice'	+	+	+	+	Option 2 bolstered by dedicated EC unit/champion. Although Options 3 and 4 provide for a European 'voice', political leadership under Option 5 will be with the 'space bureau' in the Commission.
To strengthen Europe's space and technological capabilities					
to increase R&D and technological innovation	0	0	0	-	Potential for innovation likely to be reduced under Option 5
to strengthen the European scientific/ technical skill-base	0	0	0	-	Option 5 may result in reduced skill-base
to facilitate the exploitation of R&D	0	+	+	0	Options 3 and 4 (perhaps to a lesser extent) may provide more opportunities to match R&D outputs with user requirements

Table 5.4: Potential Positive (+ve) and Negative (-ve) Impacts associated with Moving from Option 1: No Policy Change					
Criterion	**Option 2: Revised ESA/EC Framework**	**Option 3: Community Agency (under 1st Pillar)**	**Option 4: EU Agency (under 2nd Pillar)**	**Option 5: Executive Agency**	**Comment**
To maximise Europe's market access to the rest of the world					
to increase development of European independence for critical capabilities, components and technologies	0	0	0	-	Options unlikely to result in increased development beyond current European activities (as described in Section 3.2.3)
to strengthen Europe's position in international negotiations	0	+	+	+	Greater EU involvement in space should enhance negotiating powers (under Options 3 to 5)
to maintain international relations	0	-	-	-	EU focus (under Options 3 to 5) may be at expense of international relations
To improve the competitiveness of the European space industry					
to enable European companies to compete successfully in the world market	+	+	+	+	Relaxation of geo-return should stimulate European companies to compete on world markets
to allow European companies to compete for projects within Europe	+	+	+	+	All options should improve access to projects within the EU
to provide a suitable regulatory environment in which to compete	0	+	0	+	EU policies (particularly under Options 3 and 5) should provide improved conditions for competition
To enable the implementation of demand-driven space programmes					
to increase awareness of the opportunities provided by space	0	+	+	+	Greater EU involvement (Options 3 to 5) provides a basis to further raise space awareness
to better coordinate requirements of users	+	+	+	+	All options intended to lead to better coordination of user requirements
to be responsive to the requirements and views of downstream users	+	+	+	-	Options 2 to 4 should be more responsive to downstream users although this is unlikely to be case under Option 5

Table 5.4: Potential Positive (+ve) and Negative (-ve) Impacts associated with Moving from Option 1: No Policy Change					
Criterion	**Option 2: Revised ESA/EC Framework**	**Option 3: Community Agency (under 1st Pillar)**	**Option 4: EU Agency (under 2nd Pillar)**	**Option 5: Executive Agency**	**Comment**
To improve the efficient use of resources for space in Europe					
to improve coordination and reduce duplication of R&D effort	0	+	+	+	Greater EU involvement and development of integrated institutional structure (Options 3 to 5) should lead to greater coordination of resources
to increase specialisation and characterisation	0	0	0	0	Options unlikely to make a significant difference to nature/roles of facilities
to provide an overall coherent space strategy	0	0	0	0	In any event, the Space Policy/Programme will provide coherent framework
To encompass or accommodate the production of dual use (e.g. civil and defence) applications					
to be mandated to develop defence-related applications	0	0	+	-	Options 2 and 3 unlikely to be significantly different from the current situation. However, Option 4 provides obvious advantages for handling defence and security aspects. In contrast, it would be difficult to be involved in such issues under Option 5
to increase the political consensus on Europe-wide security and dual-use applications	0	0	+	-	
to increase R&D activities in areas with potential for dual-use applications	0	0	+	-	
To maximise, to the extent possible, the institutional coherence					
to minimise the level of risk/complexity involved in transitioning to each option	0	-	-	-	Creating an Agency is a lengthy, complex process (particularly for Options 3 and 4).
to minimise the degree of change from existing arrangements	0	-	0	-	Options 2 and 4 are relatively close to Option 1 in terms of relative influence of Member States and the Commission. In contrast Option 5 would be run entirely by the Commission
to have the ability to involve existing ESA (non-EU) partners	0	-	-	-	Under Options 3 to 5, the role of non-EU ESA members would be reduced
Potential positive impacts (no. of pluses)	**7**	**13**	**15**	**11**	
Potential negative impacts (no. of minuses)	**0**	**5**	**4**	**12**	

A summary of the impacts detailed in Table 5.4 is presented in Table 5.5

Table 5.5: Number of (Unweighted) Potential Positive (+ve) and Negative (-ve) Impacts associated with Moving from Option 1: No Policy Change

Criterion	Option 2: Revised ESA/EC		Option 3: Comm'ty Agency		Option 4: EU Agency		Option 5: Exec Agency	
	+ve	-ve	+ve	-ve	+ve	-ve	+ve	-ve
To contribute to European cohesion	2	0	3	0	3	0	3	0
To contribute to the position of Europe on the world space scene	1	0	1	1	1	1	1	1
To strengthen Europe's space and technological capabilities	0	0	1	0	1	0	0	2
To maximise Europe's market access to the rest of the world	0	0	1	1	1	1	1	2
To improve the competitiveness of the European space industry	2	0	3	0	2	0	3	0
To enable the implementation of demand-driven space programmes	2	0	3	0	3	0	2	1
To improve the efficient use of resources for space in Europe	0	0	1	0	1	0	1	0
To encompass or accommodate the production of dual use applications	0	0	0	0	3	0	0	3
To maximise, to the extent possible, the institutional coherence	0	0	0	3	0	2	0	3
Potential positive impacts (pluses)	**7**		**13**		**15**		**11**	
Potential negative impacts (minuses)		**0**		**5**		**4**		**12**

Note: Since there are three sub-criteria for each criterion, each criterion may have up to three potential positive (+ve) or negative (-ve) impacts.

5.7.3 Weighting of Options by Scenario

Overview

Consideration is given to four demand scenarios in Section 4. Under each scenario, there will be different priorities which can be represented by weighting the criteria (and, indeed, the associated sub-criteria) listed above. However, before assigning qualitative weights, a brief recap of the demand scenarios is presented. Where reference is made to one of the nine 'high level' criteria, this is represented by a number, for example (***4***).

Business as Usual

Under the Business as Usual (BAU) scenario, each of the criteria has been assigned equal weights. This has been taken as the starting point of the analysis and, as such, Tables 5.4 and 5.5 provide the results of the BAU scenario. By inspection of the results, it would appear that Options 3 (Community Agency) and 4 (EU Agency) have more positive impacts than Options 2 (Revised ESA/EC Framework) and 5

(Executive Agency). However, Options 3, 4 and 5 all have more negative impacts than Option 2.

Scenario 1

Scenario 1 is a relatively optimistic scenario, with a generally peaceful world, the growth of global trade and the internationalisation of production worldwide. Cooperation among nations contributes to the solution of world problems. However, organised crime and terrorism continues to be active, and the environment continues to deteriorate (although less than in other scenarios). Under Scenario 1, export potential is high as there are no barriers to global trade, thus maximising access to world markets (***4***) *per se* is not an issue. However, the European space industry has stronger competition from emerging space-faring nations, with rapid technological developments worldwide. Therefore, improving the technical capability (***3***), competitiveness (***5***) and efficiency of the European industry (***7***) are of most importance.

Scenario 2

Under Scenario 2, three major economic powers dominate the world: the US, Europe and China. The economic powers of the US and Europe are gradually weakened and they choose to strengthen ties with each other and to coordinate military forces. This gradually leads to a bi-polar world, where rivalry between Western and Eastern blocs dominates the policy agenda. European cohesion (***1***) is most important, and most complicated, under Scenario 2 as a European defence space programme is undertaken in this Scenario. This also emphasises the need to develop technological capabilities (***3***) for the purposes of security and defence (including dual-use (***8***)), particularly in the face of poor economic conditions (when innovation is low). Due to the political environment (and further development of emerging industries), access to the global markets is limited, therefore additional efforts are needed to maximise access (***4***) to the extent possible, requiring a more competitive (***5***) and efficient industry (***7***).

Scenario 3

Scenario 3 is a relatively pessimistic scenario. Strong disagreements among major powers lead to a gradual erosion of international institutions and international trade. Economic conditions deteriorate as the world reverts to protectionism and growing social and ecological problems are largely ignored. In a hostile world, with eroded international relations, Europe's space industry must be able to produce all components necessary, requiring considerable development of technological capabilities (***3***), as well as increasing resource efficiency (***7***) due to the poor economic conditions. Limited export markets remain open, and these must be exploited to the extent possible (***4***), while civil budgets are largely devoted to the development of dual-use technology (***8***).

Indicative Weightings

Given the inherent uncertainties in assessing the impacts (as presented in Table 5.4), there is perhaps limited merit in developing numerical weights in order to generate numerical results. Instead, Table 5.6 provides an indication of whether a particular criterion is likely to be weighted more or less under the various Demand Scenarios than under the BAU scenario. These are based on the starting assumption that, under the Business as Usual (BAU) scenario, each criterion is given equal weight.

Table 5.6: Indicative Weights of Criteria by Demand Scenario

Criterion		**Demand Scenario**			
		BAU	**1**	**2**	**3**
1	To contribute to European cohesion	1	less	more	less
2	To contribute to the position of Europe on the world scene	1	less	less	less
3	To strengthen Europe's space and technological capabilities	1	more	more	more
4	To maximise Europe's market access to the rest of the world	1	n/a	more	more
5	To improve the competitiveness of the European space industry	1	more	more	less
6	To enable the implementation of demand-driven space programmes	1	less	less	less
7	To improve the efficient use of resources for space in Europe	1	more	more	more
8	To encompass or accommodate the production of dual use applications	1	less	more	more
9	To maximise, to the extent possible, the institutional coherence	1	less	less	less

5.7.4 Discussion of Results

Without a detailed analysis of the weights afforded to each criterion (and to each of the three associated sub-criteria), it is not possible to determine the 'best' option (in terms of the numerical results) under each of the demand scenarios.

By inspection of Table 5.5, it can be seen that for each of the criteria where Option 2 (Revised ESA/EC Framework) is rated positively, Options 3 (Community Agency) and 4 (EU Agency) either have the same rating or are rated more highly. As such, Options 3 and 4 will always outrank Option 2 unless the relative negative ratings for these options are sufficient to outweigh this effect.

With respect to the negative ratings, Option 2 performs significantly better than Options 3 and 4 on the 'institutional coherence' criterion, and slightly better on the 'Europe on the world space scene' and 'Europe's market access' criteria. Unless a disproportionate weight is given to the importance of these three (out of nine) criteria, Options 3 and 4 will outperform Option 2 when consideration is given to both the positive and the negative ratings.

As such, in the longer term, further consideration should be given to a Community Agency (Option 3) or an EU Agency (Option 4). The Community Agency has positive impacts because it encourages EU cohesion, provides an EU 'voice' as well as being generally 'efficient'. While an EU Agency offers similar attractions, its main strength is its ability to deal with defence and dual-use issues. In contrast, an Executive Agency (Option 5), while offering efficiencies in programme implementation lacks the ability to deal with political and defence issues. As a consequence, there is little merit in pursuing this option further.

In the shorter term, the Revised ESA/EC Framework (Option 2) provide a 'half-way house' by offering advantages over the existing situation and allowing further development of the longer term options to be undertaken. As already indicated, the crucial factor will be how to deal with defence and dual-use issues. Although there may be arguments for and against a Community or EU Agency, there are other possibilities including an Agency which spans two (or even three) pillars or, potentially, the reallocation of defence-related space issues to the European Defence Agency.

6. KEY FINDINGS

6.1 Current Space Market

European countries, led by France, Germany, UK, Italy, Belgium and Spain, are involved in space activities. The EU is also becoming a significant actor and contributor of funds. The annual European institutional civil budget is steadily increasing and is now over €5 bn, most of which is directed through the European Space Agency (ESA). The annual European institutional military budget is much lower at less than €1 bn[98]. Although Europe is the second largest global player in space, its annual institutional budgets are dwarfed by those of around €13 bn and €15 bn for the US civil and military budgets respectively.

Detailed analysis suggests that the annual turnover of the European space manufacturing industry from European institutional budgets is about €2.7 bn (i.e. nearly 50% of the total budget) - although uncertainties remain in the differences between the institutional budgets and the industry's turnover.

The commercial space market is usually characterised as having three segments - telecommunications, Earth observation and navigation. Although the European downstream market (comprising commercial value-added services) is large, the value of the 'space' element (development, construction, launch and maintenance of satellites) is less than €2 bn per annum to the European manufacturing industry. Although much more cyclic in nature than the institutional budgets, recent years have seen an increase in commercial markets.

Most areas of space activity involve limited numbers of key players. Europe has three of the 20 global satellite manufacturers and one of the four global commercial launcher companies. Similarly, in the important fixed satellite services (FSS) market, two European companies account for 30% of the global turnover.

6.2 Regulatory and Other Issues

6.2.1 Overview

The European space industry operates within a complex framework of requirements. These requirements were assessed and consultation was held with a range of stakeholders to assist in identifying the key areas where measures could be taken at an EU level to improve the situation (with particular regard to market access).

The two key issues (as discussed further below) are:

- controls over the exchange of items (or ideas) which may have both civil and military (dual-use) implications; and

[98] European military space budgets declined in the late 1990s before increasing again.

- reaching international agreements on operational ‘slots’.

A further issue which is emerging in importance is that of liability relating to space debris. This was an area where stakeholders felt that future regulation at a European level (and associated negotiations at a global level) could provide greater clarity and harmonisation.

6.2.2 Dual-use Export Controls

There are two control regimes of interest - EU exports and ITAR.

Although the EU export of items with the potential for military use is subject to EC Regulation 1334/2000, there is a widespread view that the regulatory regime needs to be improved. To address such concerns, the Commission published (in December 2006) a *Communication on the Review of the EC Regime of Controls of Exports of Dual-use Items and Technology*. The purpose of this Communication is to improve clarity, coordination and security over the potential export of dual-use items from the EU.

The corresponding US system is ITAR (International Trade in Armaments Regulations) which is applied rigorously by the US to restrict the export of sensitive technology (and ideas) from the US. Whilst ITAR can create difficulties for European industry in, for example, obtaining critical components from the US, it can also provide opportunities. In particular, European companies can offer ITAR-free systems (for some applications) for export, thus gaining market share over the US. As such, on balance, ITAR is not seen as major problem for the European industry.

6.2.3 Allocation of Slots

Satellite communications rely on the use of selected frequencies of the radio frequency (rf) segment of the electro-magnetic spectrum as well as selected geographical positions of satellites. These frequency/position ‘slots’ are allocated by the International Telecommunications Union (ITU). Although the procedures appear to work well, some stakeholders suggested that there is increasing competition for particular slots, especially from terrestrial operations. As such, operators would welcome an additional European ‘voice’ in support of applications for slots for European space activities.

6.2.4 Potential Impacts of Regulatory Issues

The space industry is characterised by large infrequent projects. Satellites are very expensive, typically costing the order of €200m. As such, the loss of a satellite or space related contract or failure to obtain a required ‘slot’ can have serious implications for companies involved in the space sector.

6.3 Demand Scenarios

6.3.1 Introduction

There is sufficient information available to provide robust estimates for the numbers of satellites launched in recent years (and, to a lesser extent, associated market value) and for those to be launched in the next few years. Thereafter, the future becomes less certain and three demand scenarios were considered in addition to the Business as Usual (BAU) scenario. The scenarios were initially based on those developed by OECD in its predictions for the space industry to 2030, but have been refined following detailed examination and review during the course of this study (as outlined in Annex 3).

6.3.2 Scenario 1

Scenario 1 is a relatively optimistic scenario, with a generally peaceful world, the growth of global trade and the internationalisation of production worldwide. Cooperation among nations contributes to the solution of world problems. However, organised crime and terrorism continues to be active, and the environment continues to deteriorate (although less than in other scenarios).

6.3.3 Scenario 2

Under Scenario 2, three major economic powers dominate the world: the US, Europe and China. The economic powers of the US and Europe are gradually weakened and they choose to strengthen ties with each other and to coordinate military forces (including a European military space programme). This gradually leads to a bi-polar world, where rivalry between Western and Eastern blocs dominates the policy agenda.

6.3.4 Scenario 3

Scenario 3 is a relatively pessimistic scenario. Strong disagreements among major powers lead to a gradual erosion of international institutions and international trade. Economic conditions deteriorate as the world reverts to protectionism and growing social and ecological problems are largely ignored.

6.3.5 Demand Scenario Summary

The demand scenarios are summarised in Table 6.1.

Table 6.1: Demand Scenarios for Europe (2012-2021)				
	BAU Scenario	**Scenario 1**	**Scenario 2**	**Scenario 3**
Commercial Market				
Growth	+4% pa	+7% pa	+3%	-10% pa
Satellites/year	5 per year	6 per year	5 per year	2 per year
Institutional Civil Market				
Growth	+2% pa	+10% pa	+2% pa	No growth
Satellites/year	7 per year	11 per year	8 per year	5 per year
Institutional Defence Market				
Growth	-2% pa	No growth	+10% pa	+5% pa
Satellites/year	1 per year	2 per year	6 per year	5 per year
Total satellites	**13 per year**	**19 per year**	**19 per year**	**12 per year**

6.3.6 Implications for European Space Industry

Although there are clearly different growth patterns amongst the various demand scenarios, the conclusion is that the steady growth (in overall terms) seen in recent years is likely to continue into the foreseeable future. The implications for the European space industry are outlined below for each scenario.

Under the Business as Usual Scenario, the commercial and institutional civil markets continue to expand. However, the institutional defence market declines due to greater use of commercial applications for military uses and greater coordination amongst European states.

Under Scenario 1, the commercial market is strong and private investment in space increases. Commercial interests increase in navigation and Earth observation and therefore the private sector takes on greater responsibility for these applications. Export potential is high as there are no barriers to global trade, but there is stronger competition from emerging space-faring nations. Therefore, efforts to improve technical capability, competitiveness and efficiency are of most importance under this scenario in order to sustain the European space industry.

Under Scenario 2, European institutions take on responsibility for security and defence applications, whilst Members States maintain some roles in civil applications such as space science, Earth observation and telecommunications. High levels of uncertainty about the macroeconomic climate and about the demand for satellite-based services will have a detrimental effect on the private sector's propensity to invest in satellite infrastructure. Due to the political environment (and further development of emerging industries), access to the global markets is limited, therefore additional efforts are needed to maximise access to the extent possible, requiring a more competitive and efficient industry.

Under Scenario 3, economic conditions deteriorate as the world reverts to protectionism. Restrictions on imports of components from the USA and Japan could have a significant detrimental impact on the European space industry's ability to manufacture cost-effective satellite systems. Member States take a greater role in both civil and military applications. Limited export markets remain open, and these must be exploited to the extent possible, while civil budgets are largely devoted to the development of dual-use technology. There is more investment (in comparison to BAU) from the military sector in response to the more difficult security situation and this contributes to maintaining and developing the technical knowledge base in Europe.

6.4 Evolution of the ESA/EC Framework

6.4.1 Background

ESA is an inter-governmental organisation which has led the European space effort for the past 30 years. There are 17 ESA Member States comprising the EU-15, Norway and Switzerland with formal cooperation agreements with a number of other countries. Many projects funded by Europe's national civil space budgets are managed by ESA. In some cases, partial funding is provided by the European Community (EC). ESA and EC have also established joint structures to manage large projects such as Galileo. In addition, ESA co-operates with the EC under a formal ESA/EC Framework Agreement.

The future evolution of ESA/EC co-operation will form a key part of the *European Space Policy* and the associated *European Space Programme*, currently being prepared by the European Commission and ESA.

6.4.2 Options for Evolution

There is a perception that the current arrangements for managing the development and exploitation of European space activities need to evolve, *inter alia*, to be more inclusive of all EU Member States, to ensure that Europe maintains its position on the world stage and to stimulate and sustain a competitive European space industry. Such an evolution is likely to lead to greater involvement of the EU.

Four options in addition to ***Option 1 - No Policy Change*** were considered in the analysis:

Option 2 - Revised ESA/EC Framework. Option 2 has been taken to represent a possible evolution of the existing framework. As such, most institutional civil space activities will continue to be run by ESA, headquartered in Paris, with cooperation from the EC. However, some steps are taken to increase European participation and efficiency. It is also proposed that consideration be given to aligning ESA policies for work allocation more closely to the principles of EU competition policy.

Option 3 - European Community Agency. In the longer term, it would be possible to establish a Community Agency under the EU's first pillar. Although the role of non-EU ESA Member States (Switzerland and Norway) would be diminished, they would still be able to participate in the activities of a Community Agency. The overall direction of the Community Agency would be the joint responsibility of Member States and the Commission (as represented on the Administrative Board). The focus of the activities of a Community Agency would be on civil projects and, as such, should not lead to substantial changes in the nature of the work undertaken. However, it would be expected that one area of potential change would be that projects would be awarded to contractors on the basis of rules and procedures more closely aligned to those of the EU.

Option 4 - European Union Agency. In the longer term, it would be possible to establish an EU Agency under the EU's second pillar. As for Option 3, this would be a complex and lengthy procedure and the role of non-EU ESA Member States (Switzerland and Norway) would be diminished although co-operation with non-EU countries would continue to be encouraged. The overall direction of the EU Agency would be the responsibility of Member States. The focus of the activities of an EU Agency would span all space activities including projects with (potential) dual use applications. This would lead to changes in the emphasis of the work undertaken but would not necessarily requires changes in the staff undertaking technical and administrative duties. It would be expected that work allocation rules would be determined by Member States (through the Administrative Board).

Option 5 - Executive Agency. The establishment of an Executive Agency represents the greatest change from Option 1 and would (effectively) move the responsibility for European space activities to the Commission. The Executive Agency would be responsible for implementing the 'space' programme. However, one area of significant change would be that projects would be awarded to contractors on the basis of EU rules and procedures. There would also be a need to establish a focal point within the Commission (in Brussels) to first develop the programme for implementation by the Executive Agency. This Space Bureau would also be responsible for 'space' policy issues.

6.4.3 Comparison of Options

The expected 'performance' of each of the options relative to ***Option 1 - No Policy Change*** was rated against an agreed set of nine criteria. To improve the clarity of the analysis, each of these criteria was defined in terms of three sub-criteria.

Each of the 27 sub-criteria was rated using a simple system:

-	*Option likely to result in a negative impact*
0	*No change from Option 1*
+	*Option likely to result in a positive impact*

Although the analysis was based on the assumption that each of the criteria (and associated sub-criteria) would carry an equal weight, inspection of the results suggests that the overall results are relatively insensitive to the weighting of individual criteria. This, in turn, suggests that although some differences in the relative weighting of criteria under the different demand scenarios would be expected, the overall results are likely to remain unchanged.

The overall results were that, in the longer term, further consideration should be given to a ***Community Agency (Option 3)*** or an ***EU Agency (Option 4)***. The Community Agency has positive impacts because it encourages EU cohesion, provides an EU 'voice' as well as being generally 'efficient'. While an EU Agency offers similar attractions, its main strength is its ability to deal with defence and dual-use issues. In contrast, an ***Executive Agency (Option 5)***, while offering efficiencies in programme implementation lacks the ability to deal with political and defence issues. As a consequence, there is little merit in pursuing this option further.

In the shorter term, the ***Revised ESA/EC Framework (Option 2)*** provides a 'half-way house' by offering advantages over the existing situation and allowing further development of the longer term options to be undertaken. In particular, further consideration will need to be given to dealing with defence and dual-use issues. Although there may be arguments for and against a Community or EU Agency, there are other possibilities which could be considered including an Agency which spans two (or even three) pillars or, potentially, the reallocation of defence-related space issues to the European Defence Agency.

7. REFERENCES

Achache J (2003): *A New Perspective for Earth Observation*, ESA Bulletin, No 116, November 2003, pp 22-33.

ASD-Eurospace (2006): **Facts and Figures: The European Space Industry in 2005**, dated June 2006, available from www.eurospace.org.

Ashbourne A (2000): **Opening the US Defence Market**, report for the Centre for European Reform (CER) dated November 2000 and available at www.cer.org.uk.

AST & COMSTAC (2006): **2006 Commercial Space Transportation Forecasts**, Commercial Space Transportation (AST) and the Commercial Space Transportation Advisory Committee (COMSTAC), dated May 2006, available from www.aia-aerospace.org/stats/resources/ast2006.pdf.

Bildt C *et al* (2000): **Towards a Space Agency for the European Union**, report prepared for ESA and launched 9 November 2000.

Bildt C & Dillon M (2004): *Europe's Final Frontier*, in **Europe in Space,** London, The Centre for European Reform dated October 2004 and available from: www.cer.org.uk/pdf/p572_space_pol_eu.pdf

BNSC (2006): **Size and Health of the UK Space Industry 2006**, Executive Summary, British National Space Centre, www.bnsc.gov.uk.

Careless, J (2005): **State of the Global Satellite Industry: By the Numbers**, dated October 2005, available from: www.satellitetoday.com/satellite/viasatellite/survey/survey2004.htm.

CEC (2003): **Green Paper: European Space Policy**, COM(2003) 17 final dated 21.01.2003 available from ec.europa.eu/comm/space/off_docs_en.html.

CEC (2003a): **Space: a New European Frontier for an Expanding Union - An Action Plan for Implementing the European Space Policy**, White Paper, COM(2003) 673 dated 11.11.2003, available from ec.europa.eu/comm/space/off_docs_en.html

CEC (2005): **Proposal for the Council and European Parliament Decisions on the 7th Framework Programme (EC and Euratom): Impact Assessment and Ex Ante Evaluation**, SEC(2005) 430 dated 06.04.2005 and available from: cordis.europa.eu/documents/documentlibrary/ADS0011908EN.pdf

CEC (2005a): **Communication from the Commission to the Council and the European Parliament: European Space Policy - Preliminary Elements**, COM(2005) 208 final, dated 23.05.2005.

CEC (2005b): **Communication from the Commission to the Council and the European Parliament: Global Monitoring for Environment and Security (GMES): From Concept to Reality**, COM(2005)565 final, dated 10.11.2005, available from: ec.europa.eu/comm/space/off_docs_en.html.

CEC (2006): **Commission Decision: Creating a Bureau for Global Monitoring for Environment and Security (GMES): From Concept to Reality**, COM(2006)673, dated 08.03.2006.

CEC (2006a): **Communication from the Commission of the Review of the EC Regime of Controls of Exports of Dual-use Items and Technology**, COM(2006) 828 final, dated 18.12.2006 (*and related documents COM(2006) 829 and SEC(2006) 1696).*

COWI (2006): **Midterm Evaluation of the Galileo Project for the Period 2002-2004**, report for DG TREN, dated June 2006.

CSA (2000): **State of the Canadian Space Sector 2000**, Canadian Space Agency, available from www.space.gc.ca.

Dillon M (2005): **Report of the Panel of Experts on Space and Security**, dated March 2005.

EISC (2004): **Final Resolution adopted at the 6th European Interparliamentary Space Conference**, 10-11 November 2004, Madrid.

EISC (2005): **Resolution adopted at the Seventh European Interparliamentary Space Conference**, 16-18 June 2005, available from: www.europa.eu.int/comm/space/doc_pdf/7eisc.pdf

eoVox (2006): **What Should the Public Sector do to Incubate the Earth Observation Value-adding Sector?**, report by the EO Service Sector Representation, dated September 2006.

ESA (2003): **Agenda 2007 – A Document by the ESA Director General**, dated October 2003.

ESA (2005): **Convention for the establishment of a European Space Agency**, ESA SP-1300, dated September 2005.

ESA (2005): **Annual Report 2004**, available from www.esa.int.

ESA (2006): **Annual Report 2005**, available from www.esa.int.

ESA (2006a): *Agenda 2011*, article in ESA Bulletin 128, dated November 2006.

ESA (2006b): **Draft ESA Long-Term Plan 2007-2016**, draft document dated 29 September 2006.

ESA (2006-web): **European Space Agency** website, available from www.esa.int.

ESPI (2005): **A New Paradigm for European Space Policy: A Proposal**, European Space Policy Institute Report 1, dated November 2005

ESSC (2005): **Recommendations of the European Space Science Committee (ESSC) of the European Science Foundation (ESF)**, as presented to ESA Council Meeting at Ministerial Level 5-6 December 2005.

ESTP (2006): **Strategic Research Agenda**, European Space Technology Platform, dated 22.06.06.

Euroconsult (2004): **World Market Survey of Satellites to be Launched by 2013**, Euroconsult: Paris.

Euroconsult (2005a): **World Prospects for Government Space Markets**, Euroconsult: Paris.

Euroconsult (2005b): **World Satellite Communications and Broadcasting Markets Survey – Market Forecasts to 2014**, Euroconsult: Paris.

Euroconsult (2005c): **HDTV in Europe – Key Economics & Prospects to 2015**, Euroconsult: Paris.

European Commission & ESA (2001): **Towards a European Space Policy**, COM(2001) 718 Final, available from: ec.europa.eu/comm/space/off_docs_en.html.

European Commission (2005): **Impact Assessment Guidelines,** SEC(2005) 791 dated 15 June 2005 (with 15 March 2006 update).

European Commission (2006): **Action Plan for European Standardisation**, Final, dated April 2006.

Futron (2005): **2004 Satellite Industry Statistics**, sponsored by the Satellite Industry Association, dated June 2005, available from www.futron.com.

Futron (2006): **State of the Satellite Industry Report**, sponsored by the Satellite Industry Association, dated June 2006, available from www.futron.com.

GAC (2006): **Future GMES Structures and Governance**, report of the Working Group of GMES Advisory Council, GAC(2006)6, dated 25 April 2006, available from: www.gmes.info/17.0.html

GAC (2006a): **Future GMES Structures and Governance - Synthesis of Comments**, report prepared by GMES Bureau, GAC(2006)14, dated 13 November 2006, available from: www.gmes.info/17.0.html

Huntingdon W (2005): *Congress Amends Iran Nonproliferation Act*, **Arms Control Today**, Arms Control Association, dated December 2005, available from: www.armscontrol.org/act/2005_12/Dec-NonproAct.asp

IAF (2006): **Highlights in Space Technology and Applications 2006**, report submitted by the International Astronautical Federation to the UN Committee on the Peaceful Uses of Outer Space, dated 7 November 2006, available from www.iafastro.com

IMS (2006): **Impact Assessment Study on Possible Options for the Modification of the EU Regime on Export Control of Dual-use Goods and Technologies**, report prepared for European Commission Services by Interexport Management Systems Ltd, dated February 2006.

ISBC (2005): **State of the Space Industry 2005**, International Space Business Council, August 2005.

Istituto Affari Internazionali (2003): **Space and Security Policy in Europe**, report prepared for ESA, dated November 2003 available from www.iai.it.

Johnson R (2006): **Europe's Space Policies and their Relevance to ESDP**, report for European Parliament (DG for External Policies of the Union), dated June 2006.

Mattner M (2006): *Galileo Programme Status*, presentation in Brussels 23 May 2006

Mitsis N (2005): **Via Satellite's Measuring the State of the Industry**, dated July 2005, available from www.satellitetoday.com/satellite/viasatellite/survey/survey2004.htm.

OECD (2004): **Space 2030: Exploring the Future of Space Applications**, OECD: Paris.

Pasco X (2006): **A European Approach to Space Security**, prepared for the Advanced Methods of Cooperative Security Program at the Center for International and Security Studies at Maryland, University of Maryland, dated July 2006, available from www.cissm.umd.edu/papers/files/pasco2006.pdf

PMDTC (2006): *The Directorate of Defence Trade Controls (DDTC) and Defence Trade Function*, document available from www.pmdtc.org/docs/ddtc_overview.doc

Reinsch WA (2000): **US Satellite Export Policy**, Testimony of Under Secretary William A Reinsch, US Department of Commerce, available from: www.bis.doc.gov/News/archive2000/SatelliteExportPolicyCongTest.htm

Satmagazine.com (2006): *Industry News*, Satmagazine.com, dated July-August 2006, Vol.4 No.4, pp5-9.

Space.com (2000): **Arianespace Executive Says Launcher On Schedule**, article downloaded from www.space.com/peopleinterview/arianespace_mondale_000801.html

Space Daily (2005): *Putin Attacks US Curbs on Russian Space Exports*, **Space Daily**, June 25 2005, available from: www.spacedaily.com/reports/Putin_Attacks_US_Curbs_on_Russian_Space_Exports.html

Sourisse P (2006): Industrial Vision, Status and Trends, presentation given at ESTEC, dated May 29 2006, available from www.eurospace.org.

Valasek T (2004): *Galileo's 'Strategic' Role,* in **Europe in Space,** London, The Centre for European Reform dated October 2004 and available from: www.cer.org.uk/pdf/p572_space_pol_eu.pdf

Zelnio R (2006): *The Effects of Export Control on the Space Industry*, **The Space Review**, dated January 16 2006, available from www.thespacereview.com/article/533/1

ANNEX 1:

TASK SPECIFICATIONS

EUROPEAN COMMISSION
ENTERPRISE AND INDUSTRY DIRECTORATE-GENERAL

Aerospace, security, defence and equipment
Space policy and coordination
Acting Head of Unit

Brussels,
ENTR H2/AC D(2005) 18844

Annex A: Task specifications for the assignment:

Impact assessment under lot n° 2

The study of the economic and governance evolution of Space in Europe

1. *1. BACKGROUND*

1.1.1. 1.1 Towards a European Space Policy

Over the past decade, the Commission has become increasingly convinced that space technologies can bring essential support to the Union's policies and objectives and deliver substantial strategic, social, economic, and commercial benefits. This view has been supported by the Council and has led, in turn, to a growing European Community involvement in research and development related to satellite applications, a commitment to the development of clear policies on space-related issues and the introduction of operational satellite systems with EC support.

The international political significance of space has also grown. In addition to specific issues such as export control and non-proliferation, space is more generally taking a higher profile in the Union's dialogues with major partners.

As these developments have occurred, the Commission responded to encouragement from the Council and has strengthened its close cooperation with the established intergovernmental organisation for the development of space technologies in Europe, the European Space Agency (ESA). ESA continues to invest in space technologies and systems, in order to secure European capabilities to meet European and global market needs and to push back the boundaries of scientific knowledge.

The Commission and ESA are now drafting a European Space Policy (ESP) and the associated European Space Programme, in consultation with the Member States of the EU and ESA. The Commission Communication "European Space Policy - Preliminary Elements" stated that the European Space Policy would consist of: a strategy outlining the objectives; the definition of the roles and responsibilities of the main actors in delivering these objectives; the European Space Programme identifying the priorities of the main actors; and a set of implementing principles agreed amongst them. Based on this, an outline structure has already been established as a working tool for the drafting process (see Appendix 1).

Through the adoption of the ESP, space-related activities in Europe should become more effective in the achievement of economic and strategic benefits, as well as more efficiently delivered. The results of this should be reflected in the increased use of space-based systems, in turn promoting increased investment in both technologies and operational systems.

The Commission needs to produce a rigorous analysis of the impact of the different policy options under consideration (see guidance documents provided separately[1]). The present study aims at providing the necessary information to help establish objectively those impacts, where they are identifiable, and their value, where they are measurable.

1.1.2. 1.2. Industry and Markets

There have also been significant developments in this period outside these institutional frameworks. The near collapse of the commercial market for telecommunications satellites has recovered to a stable but much lower plateau. This has impacted equally on the commercial launch market.

There has been substantial consolidation in the space industry, sometimes ahead of and sometimes driven by consolidation in the defence industry. This has occurred both in Europe and the US. There remain only two large systems integrator prime contractors in Europe and even they have cooperated in the development of the largest commercial satellite platform. In the US there are three firms which have such a comprehensive capability. In parallel, however, the market has seen the rise of companies specialising in producing small satellites, establishing niches in part of the range from 50 kilos upto 2000 kilos.

In the US the largest market is the Department of Defense, which is also one of the largest investors in space-related R&D. In contrast, the defence market in Europe is both smaller than the civil market and more likely to exploit technology developed in the civil sector. Considerable efforts have been made to raise consciousness in Europe concerning the scope which space systems have to offer in support of defence and security applications. Security considerations have been one of the factors leading several European nations to order surveillance satellites.

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[1] 'Communication from the Commission on Impact Assessment' (COM(2002) 276 final, 5.6.2002)

'Ex-ante Evaluation and Impact Assessment: complementary means to assess a proposal' (DG Enterprise ENTR/R5/SH/mm D(03) 955005)

'Ex Ante Evaluation a Practical Guide for Preparing Proposals for Expenditure Programmes' (DG Budget December 2001)

An internationally competitive space industry is central to the achievement of Europe's economic and political objectives. It employs a high skilled labour force, key for a knowledge based economy. The implementation of the European Space Policy requires an industry policy specific to the sector, enabling Europe to maintain know-how and independence in critical technologies as well as competitiveness, without distorting competition.

The European space industry is highly dependent on commercial contracts open to global competition. The relatively low level of the European institutional markets, which is also often open to overseas suppliers, makes industry vulnerable to any market downturn. Recent decisions on ESA budgets, as well as on the FP7 budget for 2007-2013 provide a good visibility on the European institutional market for the years to come, as well as on the discrepancy between these and the American space budgets.

Policies have to have regard to the need to maintain strategic capabilities and competences within Europe, as well as to ensure productivity. In certain areas, reliance on US technology is a necessary constraint on the ability to compete in global markets. The foreseeable market developments and the international competition should be analysed in the light of the orders and technological investments necessary to maintain the European space industry at the spearhead of its domain.

1.1.3. 1.3. Governance

In the definition phase of the European Space Policy it is also fundamental to identify and encourage the most effective sharing of tasks and responsibilities between the main public actors for determining and continuously delivering the benefits of space to the Union and its citizens. The successful implementation requires a system of governance in which the roles of the players are clearly understood, the tools for coordination function effectively and accountability maintained. Duplication and fragmentation of work and structures must obviously be avoided.

The orientations of the second "Space Council" on 7 June 2005 invited the EC/ESA Joint Secretariat, in close consultation with the High-level Space Policy Group, to identify possible cost-efficient governance scenarios. These scenarios should focus on the optimisation of the organisation of space activities in Europe in the future and be compared to present processes, taking all relevant factors into account.

Several governance scenarios can be envisaged and the legal framework should move in parallel to the institutional evolution. The examples given in task E below are not exhaustive, nor mutually exclusive – indeed some may compliment others, being appropriate during different timescales.

2. 2. *SCOPE AND OBJECTIVES OF THE ASSIGNMENT*

The study is to be conducted under Lot number 2 (Impact assessments on industrial Products and Services sectors) of the framework contract. The objectives are:

- to assemble information on the principal markets for space and space-related hardware and services and a range of realistic scenarios for market development;
- to establish the ability of European industry to achieve a significant share of profitable sales in those markets which are accessible and identify factors within the European Space Policy which may affect that position;
- to consider the roles which key public sector actors in Europe have in influencing the competitiveness of the industry and assess the impact of different options for organising public sector activities.

3. 3. *TASKS*

Phase 1

3.1. Task A. Analyse and summarise the present space market based on published sources

The contractor should draw extensively on the reference documents listed in Appendix 2 and on other available sources, summarising and synthesising these where it is valuable to do so.

A1. Global demand:

A.1.1. Institutional Civil, Military and Commercial markets worldwide

A.1.2. Main trade flows; exports and imports in Europe and the USA

A2. Main satellite manufacturers and new players worldwide, turnover, profits/loss, market share

A3. Satellite communications markets:

A.3.1. Main players worldwide, turnover, profits/loss, market share

A.3.2. Niche markets

A.3.3. Transponders availability and lease prices

A4. Other satellite applications markets:

A.4.1. Main players worldwide, turnover, profits/loss, market share

A5. Launchers market, including new players and ventures

A6. Cost structure and competitiveness of the European launch industry and European satellite manufacturing industry versus their main competitors.

3.2. __B. Compile demand scenarios over the next 15 years for__

B1. The future worldwide space commercial market:

B.1.1. Space application market forecasts,

B.1.2. Commercial space transportation forecasts: number of launches foreseeable, for the different categories of satellites, per market

B2. The use of constellation of satellites vs big platforms

B3. The future European civil institutional market

B4. The future European defence institutional market

3.3. __C. Select from these scenarios, 3 which are most realistic and representative of a range of future demand__

The contractor will make a proposal, with the decision on the actual selection to be confirmed by the Commission after discussion in the steering committee.

Phase 2

3.4. ***D. For each of these 3 scenarios, estimate***

D1. The achievable order book for European industry and, within this, the balance between commercial and institutional (civil and military); this assessment may be sub-divided between launchers and satellites if appropriate.

D2. An assessment of whether the achievable order book will be sufficient to maintain a sustainable Space Industrial and Technological Base in Europe.

D3. The necessary investments to ensure the sustainability of the European technological know-how in the space domain and the feasible balance between private sector and public sector investments.

D4. Taking into account the roles and responsibilities described in 'Preliminary Elements' and endorsed by the Space Council, the activities and investments likely to fall to each of:

- The European Community
- The European Space Agency
- The Member States, their Space Agencies, defence ministries and regional bodies
- The European Defence Agency
- Other entities at European level

3.5. ***E. Analyse the impact of a series of hypothetical models for the management of European public sector space activities, in conjunction with the representative selection of scenarios:***

The models listed in E1-E2 below should be assessed in order to identify the extent to which they can be expected to:

a. contribute to European integration and reinforce the position of Europe on the world scene

b. strengthen Europe's capabilities in space and technological capabilities

c. allow the implementation of demand-driven programmes

d. improve the efficient use of resources for space in Europe

e. reinforce the competitiveness of European industry and

f. encompass dual use applications.

The consultant may include other factors which it may find to be relevant, based on its work up to this point in the study.

The report may illustrate the analysis by reference to particular programmes and should take account of the report of the GMES Advisory Council Working Group on Governance, expected to be finalised in April 2006. It should distinguish between:

a. political governance, i.e. the way in which strategic options are defined and major objectives and guidelines established, including international relations aspects; and

b. programmatic governance, i.e. the way in which activities and programmes are elaborated and managed.

It is proposed to reflect along two major classes of model, including any legal adaptations necessary to implement them, and to assess their consequences:

E1. Within the current frame of the current status of the EC and the ESA:

Against a background in which the EU is taking substantially more responsibility for (i) identifying and bringing together user needs, (ii) aggregating the political will in support of these, it might take increased responsibility for (iii) ensuring the necessary technology developments to meet these needs and (iv) ensuring the availability and continuity of services to support them and their related policies, implying that the EU might also increase its investments in public space-related and terrestrial infrastructures (including access to space) required for the deployment of integrated operational services. As a consequence it could consider:

a. to externalise to ESA the management of some or all EU space-related activities;

b. to participate in ESA optional programmes; or

c. to establish further joint structures with ESA or with ESA together with Member States.

These could occur under the possibilities permitted by (a) the current EC-ESA Framework Agreement or (b) under a renegotiated EC-ESA Framework Agreement and should also take into account any effects of the differences in membership between the EU and ESA.

E2. An evolution in a **longer timescale** under which space activities in Europe might be conducted within:

(a) a model in which ESA would be brought eventually in the Treaty framework as a European Community Agency; or

(b) a model in which ESA would be brought eventually in the Treaty framework as a European Union Agency; or

Individual Member States might consider whether there would be value to increase cooperation and integrate their national space agencies more closely in a network of competences in a European frame.

The implications for, and position of, other organisations, for example with operational roles in space, their long-term relationship with their Member States and the contribution they will bring to the European Space Programme should also be considered.

This assessment should consider all aspects, including the propensity of industry and Member States to invest. It should take into account the implementing principles proposed for inclusion in the ESP, including the geographical return principle which has applied to ESA as well as to many national civil and defence space programmes and the rules governing relevant EU programmes.

F. Analyse the main impacts of regulation on European space manufacturers and operators

Through interviews with space industry manufacturers and operators, identify core areas of regulation which impact particularly on companies in Europe and prioritise areas for potential future in-depth study according to their economic impact and the ease of overcoming problems.

G. Produce interim draft report, which may be in summary form, supported by PowerPoint presentation

3.6. *H. Discussion of draft report with Commission and ESA Executive*

Present preliminary findings based on draft report to the Commission and ESA Executive (meeting to be arranged by Commission through Joint Secretariat). Based on this discussion, the contractor will agree with the steering committee those aspects of the report which need to be adapted, or where analysis needs to be strengthened in order to meet the original specifications.

Phase 3 – deliver final report

4. 4 *APPROACH AND METHODOLOGY*

The contractor must outline the proposed methodological approach in his offer, which may include the use of such tools as:

- Desk research
- Qualitative and quantitative analysis of existing reporting.
- Analysis of existing documents.
- Desk-based case studies of the evaluated activities in order to assess the results achieved so far as well as the perception by stakeholders.
- Desk-based comparative analysis of [the subject], its objectives, scope, means and instruments.

Interviews with

- EU officials in DG Enterprise and Industry and other services
- Relevant National officials responsible for space, transport, technology and user policies
- Selected representatives from manufacturing and service industries, including SMEs
- Other stakeholders such as users of space services and potential users of future space services.

Any other tools deemed appropriate for the purpose of the evaluation. Note that questionnaires are not foreseen. Any proposal to conduct a questionnaire should be explained explicitly in the proposal.

5. 5. SUPERVISION OF THE STUDY, MILESTONES AND DELIVERABLES

Steering committee

The conduct of the overall Impact Assessment is under guidance from the Interservice Task Force. For the purposes of managing the consultancy study, DG Enterprise will establish a small steering committee which may include representatives from other Commission services and from international organisations. This committee will review the methodology adopted by the consultants, its selection of specialist experts to conduct the work, progress of the study and production of its final report.

Kick off meeting

Within two weeks of the signing of the documents under which the study is conducted, a formal kick-off meeting will take place to review the project team and project plan. All subsequent deadlines are calculated from the effective date of this meeting.

Preliminary report

The consultants will produce the report covering Tasks A and B, together with reasoned recommendations under Task C within 6 weeks. This will be accompanied by a first draft outline structure of the Final Report and a detailed work plan for the remainder of the study.

First interim review meeting

A formal interim review meeting will take place within 7 weeks. At this meeting, the steering committee will discuss the Preliminary Report, review overall progress and review the project plan. Within one further week (week 8), the Commission will confirm the selection of scenarios under Task C.

Interim draft report

The interim draft report should be delivered within 6 further weeks (week 14). This may be in summary form but should show all principal assumptions, key evidential sources and all major conclusions. The supporting PowerPoint presentation must be available at or before the Second interim review meeting.

Second interim review meeting

A formal interim review will take place within 2 further weeks (week 16). At this meeting the steering committee will review progress of the project, review the content of the interim report and decide whether the summary and presentation are of sufficient quality and merit to be made available to a wider group of stakeholders. It will also indicate whether any areas require further work immediately or during the remainder of the study (following the consultation with stakeholders).

High level seminar

After a further 2 weeks, (week 18) a high level consultation seminar will be held (subject to confirmation and to the steering committee concluding that the interim draft report and presentation are of sufficient quality and merit to be made available in this way) with representatives of the Commission and the ESA Executive. The Commission will be responsible for the arrangements for this meeting, which is anticipated to last between two and three hours. Discussions will take place as necessary following this meeting between the contractor and the steering committee or its representatives.

Draft Final Report

A final report should be provided after a further 6 weeks (week 24). This will be a full text report, including an executive summary, and coupled with a PowerPoint presentation of the results.

Final review meeting

A formal final review meeting with the steering committee will take place within 3 further weeks (week 27) to consider whether the draft final report fulfils the requirements of the study.

Final report

Should further changes be necessary, the finalised report will be provided within a further 4 weeks (week 31).

Presentation of final report

The contractor will make provision for the Commission to exercise an option for a one day presentation and discussion of the final report with interested parties, at the Commission's discretion. The Commission reserves the right to make the Final Report public.

The above schedule is compiled taking account of the summer break. It does not take account of the Christmas/New Year break. If the schedule extends into that period, two weeks will be added to all later deadlines.

Documentation

Having regard to the working language of the space community when interpretation facilities are not available, all documents will be in English.

Termination

The Commission reserves the right to terminate the study if progress or content are considered to be unacceptable on the occasion of any review meeting and, in the opinion of the Commission, the situation is such that it cannot be rectified within a reasonable period.

Appendix 1

Structure for European Space Policy

[working hypothesis 01.05.06]

6. SUMMARY

1. STRATEGY

2. EUROPEAN SPACE PROGRAMME

2.1. Foundations

2.1.1. Science and exploration

2.1.2. Technology

2.1.3. Access to space

2.2. Applications

2.2.1. Satellite communications

2.2.2. Earth observation – GMES

2.2.3. Navigation – Galileo

2.2.4. Security

2.3. National and multilateral-led activities

2.4. Priorities and costs

3. IMPLEMENTING PRINCIPLES

3.1. Governance

3.1.1. Roles and Responsibilities

3.1.2. Institutional Framework

3.1.3. National contributions

3.2. Industry Policy

3.2.1. Regulation, standardisation and IPR

3.2.2. International markets

3.2.3. Procurement policy

3.2.4. Industrial return policy

3.3. International relations

7. *APPENDIX 2*

8. *EXISTING DOCUMENTATION AND INFORMATION*

I - Key documents

- Communication from the Commission to the Council and the European Parliament, *GMES: from concept to reality*, COM(2005) 565 final, 10 November 2005. Online: http://www.europa.eu.int/comm/space/doc_pdf/comm2005-565.pdf

- Communication from the Commission to the Council and the European Parliament, *Space Policy – Preliminary Elements*, COM(2005) 208 final, 23 May 2005. Online: www.europa.eu.int/comm/space/doc_pdf/pep.pdf

- Communication from the Commission to the Council and the European Parliament, *Progress report on Galileo*, COM(2004) 112 final, 18 February 2004.Online: http://www.europa.eu.int/eur-lex/en/com/cnc/2004/com2004_0112en01.pdf

- *White Paper on Space: a new European frontier for an expanding Union – An action plan for implementing the European Space Policy*, COM(2003) 673, 11 November 2003. Online: www.europa.eu.int/comm/space/whitepaper/pdf/whitepaper_en.pdf.

- *Framework Agreement between the European Community and European Space Agency,* 7 October 2003. Online: http://www.europa.eu.int/comm/space/doc_pdf/agreement_en.pdf

- *Agenda 2007*, a document by the ESA director General, October 2003. Online: http://esamultimedia.esa.int/docs/BR-213.pdf

- Council *Resolution on the Development of an overall European Space Policy*, 13 May 2003. Online: http://www.europa.eu.int/eur-lex/pri/en/oj/dat/2003/c_149/c_14920030626en00100010.pdf

- *Green Paper: European Space Policy,* COM(2003) 17 final, 21 January 2003. And the results of the consultation. Online: http://www.europa.eu.int/comm/space/doc_pdf/greenpaper_en.pdf

- Communication from the Commission to the Council and the European Parliament, *Towards a European Space Policy*, COM(2001) 718 final, 07 December 2001. Online: http://www.europa.eu.int/comm/space/doc_pdf/spacetoward_en.pdf

- Communication from the Commission to the Council and the European Parliament, *Europe and Space: Turning to a new chapter*, COM(2000) 597, 27 September 2000. Online: http://www.europa.eu.int/comm/space/space01/pdf/esa_en.pdf

II - Orientations from the Space Council

- Orientations from the third Space Council, 28 November 2005. Online: http://europa.eu.int/comm/space/doc_pdf/st14499-re01en05.pdf

- Orientations from the second Space Council, 7 June 2005. Online: http://www.europa.eu.int/comm/space/news/docs/orientations_space_en.pdf

- Orientations from the first Space Council, 24 November 2004. Online: http://www.europa.eu.int/comm/space/doc_pdf/first_space_council_orientations.pdf

III – Experts' Reports

- Report on Policy Challenges and Budgetary Means of the enlarged Union 2007-2013 (2004/2209(INI)) from the Temporary Committee on Policy Challenges and Budgetary Means of the enlarged Union 2007-2013. Online http://www.europarl.eu.int/meetdocs/2004_2009/documents/pr/561/561325/561325en.pdf

- European Space Policy Institute, *A new paradigm for the European Space Policy: a proposal*, 1 November 2005. Online: http://www.espi.or.at/home/index.php?download=ESPI-Report1-nov2005-final.pdf

- Resolution adopted at the seventh European Interparliamentary Space Conference, 16 – 18 June 2005. Online: http://www.europa.eu.int/comm/space/doc_pdf/7eisc.pdf

- Organization for Economic Co-operation and Development, *Space 2030. Tackling Society's Challenges*, 13 June 2005. Online: http://www.oecdbookshop.org/oecd/display.asp?lang=EN&sf1=identifiers&st1=032005011P1

- ESYS Consulting report under FP6 contract, *GOSIS Report on potential GMES organisational models* (not published)

- PricewaterhouseCoopers study under ESA contract *GMES Benefits and Impacts* (not yet finalised)

- *Report of the Panel of experts on Space and Security*, March 2005. Online: http://europa.eu.int/comm/space/news/article_2262.pdf

- OPINION of the European Economic and Social Committee on the White Paper 'Space: a new European frontier for an expanding Union: An action plan for implementing the European Space policy' 31 March 2004. Online http://eescopinions.esc.eu.int/EESCopinionDocument.aspx?identifier=ces%5Cint%5Cint212%5Cces501-2004_ac.doc&language=EN

- REPORT Committee on Industry, External Trade, Research and Energy on European space policy – Green Paper (2003/2092(INI)) 10 September 2003. Online http://www.europarl.eu.int/omk/sipade3?PUBREF=-//EP//TEXT+REPORT+A5-2003-0294+0+DOC+XML+V0//EN&L=EN&LEVEL=2&NAV=S&LSTDOC=Y

- Organization for Economic Co-operation and Development, *Space 2030. Exploring the future of space applications,* 10 May 2004. Online:

http://www.oecdbookshop.org/oecd/display.asp?TAG=X08TT8XX4X98397812QS5W&CID=&LANG=EN&SF1=DI&ST1=5LMQCR2JGGQ5

- Bildt C., Peyrelevade J., Späth L., *Towards a space agency for the European Union*, December 2000. Online: http://ravel.esrin.esa.it/docs/annex2_wisemen.pdf

V - Evaluation of future space markets (institutional, commercial and military)

- Futron Corporation, *2004 satellite industry statistics*, June 2005. Online: http://www.futron.com/pdf/SIA_2004_Indicators.pdf

- Federal Aviation Administration, *Commercial space transportation forecasts*, May 2005. Online: http://ast.faa.gov/files/pdf/Forecast_05-05_GSO_NGSO_Comm_Launch.pdf

- Futron Corporation, *The transformation of the satellite services industry*, January 2005. Online: http://www.futron.com/pdf/Transformation_SatelliteServicesIndustry.pdf

- Euroconsult, *World prospects for government space markets*, 2005. Online: http://www.euroconsult-ec.com/research_reports_space.php

- Euroconsult, World *Satellite Communications & Broadcasting Markets Survey,* 2005. Online: http://www.euroconsult-ec.com/research_reports_space.php

- Organization for Economic Co-operation and Development, *Evaluation of future space markets*, 12 May 2004. Online: http://www.oecd.org/dataoecd/62/35/31825129.pdf

- Futron Corporation, *How many satellites are enough? A forecast of demand for satellites (2004 – 2012)*, 16 February 2004. Online: http://www.futron.com/pdf/Satellite%20Forecast%202004%20-%202012%20White%20Paper.pdf

- Euroconsult, *World Market Survey of Satellites to be Launched by 2013*, 2004. Online: http://www.euroconsult-ec.com/research_reports_space.php

- Inception Study to Support the Development of a Business Plan for the GALILEO Programme 20 November 2001 and 17 January 2003. Online http://europa.eu.int/comm/dgs/energy_transport/galileo/doc/gal_exec_summ_final_report_v1_7.pdf ; and http://europa.eu.int/comm/dgs/energy_transport/galileo/doc/gal_phase2_exec_summ.pdf

- ESYS Consulting report under FP6 contract *SATMAC* (not yet finalised)

- NASA's budget proposal for 2007, online at http://www.nasa.gov/about/budget/index.html

- ESA Annual Report 2004 (and 2005 when published)

ANNEX 2:

EMERGING SPACE INDUSTRIES

A2. EMERGING SPACE INDUSTRIES

A2.1 Introduction

This Annex provides an overview of the space industry in three major emerging countries - China, Russia and India - where the space industry is thought to have developed significantly in recent years in terms of technology, capabilities and service provision.

However, most of the investment in these countries is military-based and, as such, figures or details of their current space programmes are rarely published. Even where these are published, it is often difficult to isolate the aspects relating to space in defence and civil budgets. The sections below thus provide an overview of the current state of knowledge regarding the space industry in these three countries based on published sources and knowledgeable industry experts. The figures and data presented should thus be considered as best estimates - rather than definitive figures.

A2.2 Chinese Space Activities

A2.2.1 Overview

Although the Chinese space programme started in 1956 initially using Russian technology, it has now advanced to the level where it can deliver nuclear weapons using inter-continental ballistic missiles, put men into space and has carried out an extensive programme of over 50 satellite launches. It is generally considered to be the world's fifth largest nuclear power and the third largest space power.

In general, the Chinese military is thought to have concentrated on gaining an advantage in certain niche sectors – rather than entering an expensive space race with Western competitors. Its military space capacity is believed to be mainly defence-orientated to support the regional projection of power, particularly regarding the Taiwan Straight. Funded by China's rapid economic development and driven by the US's successful use of space technologies in the Kosovo and Iraq conflicts, many technologies have been developed or programmes started, although many fail to achieve the numbers of satellites in orbit required for a fully effective constellation. Programmes, in many cases, have dual uses, in areas of navigation, reconnaissance, communications, electronic and signals intelligence, marine surveillance, weather and possibly anti-satellite requirements. China is developing expertise in manufacturing and launching low cost micro and nano satellites which may also have military applications.

Following procurement practices in the West, China restructured its space industry during the 1990's to put overall control of activities under the People's Liberation Army General Armaments Department (PLA GAD) with civil programmes under the China National Space Organisation. The GAD controls an extensive infrastructure and network of research, development, test, launch, control and tracking facilities. The most important primary contractor is the state owned China Aerospace Science and Technology Corporation (CASIC), although a number of other firms are involved in the sector.

Despite the apparent independence of many firms and organisations involved in the space programme, China retains a strong element of central planning and command economy organisation. It is generally accepted that not only is there extensive technology transfer between the civil and military space programmes, but also that many apparently entirely civilian satellite payloads contain military elements. Although this would apply to many other countries, it is of particular significance in China – where analysts find it rather difficult to disentangle the full purposes of many programmes, the extent of civilian and military budgets and the real split of employment between the military and civil space sectors.

A2.2.2 Programmes

Launch Systems

The mainstay of China's satellite lofting programmes has been the venerable and much altered liquid fuelled series of Long March rockets. These are now giving way to second-generation solid fuelled KT-2 and KT-2A rockets, based on ballistic missile delivery technology that will significantly improve its ability to place payloads in space. It is believed that there were 34 at least partially military launches in the ten-year period to 2003 (IISS).

Reconnaissance Satellites

China uses reconnaissance satellites for military purposes and is likely to improve both the image resolution and global coverage of these systems in the near future. Progress has been made in the various segments of the reconnaissance sector including:

- **Visible spectrum**: China has launched numerous recoverable film military reconnaissance satellites (albeit, older models) and has now developed electronic relay enabled satellites such the ZY-2 and HY-1 types. The China/Brazil Earth Resources satellites (CBERS) remote sensing programme has also almost certainly had unstated military applications and indeed China also makes military use of commercially available overseas satellite imagery. Follow on satellites (CBERS-2B to 4) should increase resolution significantly beyond the existing 20-metre limit;
- **Multispectral:** The proposed Huanjing programme would in its first phase place a constellation of three (notional disaster and environmentally monitoring) satellites into orbit, two of which would provide visible, infra-red and multispectral imaging. The second phase provides for a constellation of eight satellites, four of which would be multi-spectral imaging. Tsinghua University has also developed micro-satellites in conjunction with the University of Surrey that have the potential to provide an eventual constellation of five high-resolution multi-spectral imaging satellites that may well have military applications; and
- **Synthetic aperture radar:** It is suspected (but unproven) that China has acquired a one metre resolution SAR satellite from the a Russian firm and intends to place one SAR satellite in orbit in the first phase and four in the second.

Other programmes include:

- ***Electronic and Signals Intelligence Satellites***: This is an area where the Chinese military appear not to have focussed their efforts, preferring to rely on Russian ELINT data and terrestrial systems, although some DQ-1 satellites may have been covertly used for this purpose;
- ***Communications Satellites***: China is thought to keep a small constellation of military communications satellites in orbit, but these have a relatively short life in space and accordingly need to be replaced fairly frequently;
- ***Weather Satellite***: Existing and potential civilian weather satellites are almost certainly used to provide additional information to the military;
- ***Navigation Satellites***: China understands the military and commercial importance of navigation systems and has gained access to those of other countries as well as developing its own limited constellation of Beidou satellites. It is (along with Israel and Canada) a partner in Galileo, and has access to the Russian GLONASS and the US GPS system. Obviously such access would be denied in the event of rising military tension and is in any case downgraded to civilian levels of accuracy; and
- ***Anti-Satellite Systems***: US Congressional reports have claimed China has an extensive anti-satellite capacity based on directed energy (laser) and parasite micro-satellites. There is very little proof of this, although the Chinese do have an extensive expertise in creating intense laser beams and directing them with mirrors. We are inclined to discount such congressional reports.

A2.2.3 Industry

Expenditure

A very high degree of uncertainty surrounds China's expenditure on military space programmes. Much financial accounting for Chinese defence firms still reflects command economy principles, military budgets are opaque and usually understated. Revenues from sales of technology are frequently not disclosed and may in fact be part of an offset or export package which is often difficult to untangle.

One source (The Monterey Institute) estimates the civil space programme budget at around 10 billion yuan or just over $1 billion annually. China's latest official military budget was $29.9 billion but this is universally believed to understate its military expenditure, excluding for example research and development and purchases of defence equipment from overseas. The highest estimate available is the US DOD figure of over $90 billion while the RAND Corporation suggests a range of $42 to $51 billion. A median estimate used here is $55 billion. It should also be considered that as these figures are based on purchasing power parities (PPPs), the expenditure would of course be substantially higher because of lower Chinese salary and manufacturing costs relative to the US as most data are available in US dollars.

It is generally suggested that the ballistic missile programme accounts for around 5% of the defence budget (or 10% of procurement costs) and this subsumes military satellite expenditure. In this case, the total cost of military missiles/space might be between $1.5 and $4.5 billion of spending through the armed forces, some of which will of course be directed towards ballistic missile systems.

Based on the median estimate of the military budget of $55 billion (slightly in excess of the RAND figure), missiles and space would account for approximately US$2.75 billion of spend. The cost of the civil space programme could well account for another $1 to $1.5 billion.

Companies

Because all companies have non-space products and interests, combined with complex ownership structures, double counting is difficult to avoid. Information on companies has thus been sourced from the Monterey Institute unless otherwise attributed.

The largest single firm in the Chinese defence industrial base producing space equipment is CASIC (China Aerospace Science and Technology Corporation). Its business income for 2002 was reported[99] at around 23 billion yuan ($2.7 billion) employing around 100,000 persons and hence turnover per employee is in the order of $27,400 or perhaps one quarter of western defence industry norms. In 2002, the Chinese aerospace newspaper reported that CASIC's profits reached 700 million yuan ($85 million) and its industrial gross output value increased by 17 percent (the specific output value was not mentioned).

Other major players in the Chinese space industry are:

- **China Great Wall Industry Corporation (CGWIC)** in which CASIC is a 50 per cent shareholder. The firm has carried out at least 14 satellite launches for international customers. No properly sourced turnover or employment figures are available but an estimate of 15,000 employees is not unreasonable;
- **The Beijing Wanyuan Industrial Corporation (BWYIC)** is a major manufacturing complex that employs 27,000 persons;
- **China Jiangnan Space Industry Group** (a CASIC subsidiary) employs 30,000 people;
- **China Sanjiang Space Group** employs 15,300 people has an extensive involvement in solid fuel technology and the production of space systems. The group embraces more than 100 member enterprises and production bases; and
- **The China Academy of Space Technology** employs 10,000 people and produces satellites.

A rough estimate of non-CASIC related employment in firms associated with civil and military space programmes could total a further 100,000 individuals. Using CASIC turnover per employee figures, the total industry turnover could be of the order of $5 billion. A rough estimate would suggest that Chinese firms' military

99 Jane's Space Directory 2006 and Jane's Defence Magazine Library 2001-2006

space related turnover is between $1.25 billion and $1.75 billion out of a total Chinese civil and military space related turnover of between $2.5 and $3 billion.

Space Research is undertaken at a large number of research and academic institutes. The principal centres for space research include:

- Harbin Institute of Technology (HIT);
- Nanjing University of Aeronautics and Astronautics;
- Northwest Industrial University;
- (Beijing) Institute for Space Research;
- Shanghai Radio Research Institute, and;
- Tsinghua University, which as noted earlier, developed micro-satellites in conjunction with the University of Surrey.

Employment

Although precise estimates cannot be given for total employment in China's military space activities, such a figure could exceed 250,000 persons including those working in universities, tracking centres, etc. and all those employed within the PLA (which has over 2 million personnel). A breakdown of this estimate would suggest that around 200,000 people could be working for firms producing space systems and components (amongst other activities); 50,000 to 70,000 of these workers are employed on military space projects and perhaps the same number in civil space operations.

Table A2.1 below provides a summary of the employment and turnover of space-related companies in China.

Table A2.1: Employment and Turnover of Space related Companies in China

Company	**Revenues ($ million)**	**Total employment**	**Source**
CASIC	2,740	100,000 approx	Jane's Missiles 2006
Great Wall Industry Corporation	N/a	15,000	Analysts' unconfirmed estimate
Beijing Wanyuan Industrial Corporation	N/a	27,000	Monterey Institute
China Jiangnan Space Industry Group	N/a	30,000	Monterey Institute
China Sanjiang Space Group	N/a	15,300	Monterey Institute
China Academy of Space Technology	N/a	10,000	Monterey Institute
Total Estimate	**$ 5,200 million**	**197,300**	

Overseas Revenues and Expenditures

China derives revenues from the launch of satellites for foreign governments and individuals and from the sale of missile and satellite technology to allied states. At least 14 satellites have been launched including some Iridium satellites for Motorola. This business has been damaged by US government restrictions (ITARs) and launch failures.

Items of Chinese expenditure include participation in multi-national space programmes including Galileo, purchase of commercial space imagery and purchase of space related weapons systems principally from Russia. Again, no realistic estimates of this can be made, although it is likely to average in the hundreds of millions of US dollars annually.

Summary

The best estimate is that China's military and civil space programmes cost the country over \$3 billion annually and possibly as much as \$4.5 billion, even when taking into account revenues received from technology sales, etc. Of this figure, it is estimated by both available data and industry experts that approximately two thirds of expenditure (\$2 to \$3 billion) is military-related. It is also believed that this military spend can be divided equally between ballistic missile defence and all other military space activities.

Some of this is spent overseas and a large proportion is disbursed through military budgets without reaching the wider defence industrial base. As stated earlier, it is still realistic to assume that Chinese firms benefit annually around \$1.25 to \$1.75 billion from military space activities.

Generally speaking, Chinese military space efforts are considered to be some ten to fifteen years behind those of the USA, the global benchmark nation; however, as the economy continues to grow rapidly, the gap will narrow. In launch systems, China is now acquiring reasonably reliable solid fuel rocketry.

A2.3 Russian Space Industry

A2.3.1 Overview

For many years, Russia's space industry vied for first place with the USA in both military and civil space applications. However, funding issues since the 1990s have greatly reduced its effectiveness and degraded the space industrial base and infrastructure. In particular, Russia has been unable to replace degrading satellites in orbit as quickly as required thereby reducing the effectiveness of the remaining units within the constellations. Launches are running at about one third of their previous high levels; of the 96 military and civil satellites in orbit in late 2005, it is estimated that 65 to 80 per cent are currently obsolete or failing.

Russia, however, continues to retain a very high level of technology and 'know how'. It has sought funding through sales of technology transfer to other countries and has made arrangements for countries such as India to launch some new units as part of a more over-arching understanding. As the economy expands, funding has started to increase again, albeit from a very low base. It has recently been announced that the military are receiving six new satellites during 2006.

Russia employs military or dual use satellite systems for land and sea based reconnaissance, communications, signals and electronic Intelligence, weather reporting, navigation and anti-satellite activities. At one stage it was generally assumed that all of Russian space activity, regardless of its declared purpose, was at least covertly military in its intention; it is, however, currently understood that around half of Russian space activity is now civilian or commercially orientated.

In terms of its industrial base, Russia still has extensive albeit less well supported, launch, tracking, test, research and development and manufacturing facilities. Some of these are now located outside the boundaries of modern Russia (e.g. in Kazakhstan) and their continuing use may create practical and security problems.

The Russian Federal Space Agency (RKA) was created in February 1992 to draw up and manage Russia's civil space programme. It has nine principal divisions: (state programmes, manned projects and launch facilities, implementation of state programmes, science and commercial satellites, international; ground infrastructure, external relations and legal affairs and resources and business affairs). All rocket engine organisations now come under RKA control. Purely military matters, particularly involving ballistic missiles with a nuclear potential come under the control of the President directly.

A2.3.2 Programmes

Launch Systems

Russia is second only to the USA, in its experience of developing launch systems. The existing Soyuz and Proton series of rockets have both civil and military applications and numerous more specialized launch systems have been adapted from specific military uses since the arms reductions agreements came into place at the end of the Cold War. Russia however presently lacks the funding to develop the next generation (Angara and Soyuz 2) launch systems that will eventually be required.

Reconnaissance Satellites

Russian photoreconnaissance satellite missions have perhaps been the most degraded aspect of its military space programme. The IISS report Russia has one military Araks 2 satellite in Low Earth Orbit and launched in 2002.

Electronic and Signals Intelligence Satellites

The IISS reports that Russia has one operational Tselina ELINT satellite placed in Low Earth Orbit in 2004 and one operational US/PU ocean reconnaissance satellite placed in Low Earth Orbit in 2004. Russia uses TELINT Tselina class nonmanoeuvrable satellites to eavesdrop on foreign electronic communications on a worldwide basis.

Communications Satellites

The IISS reports that Russia has the following sixteen operational communications satellites:

- Four Moiniya–1T and Moiniya–3 satellites placed in High Earth Orbit between1997-2004. Replacing the older Moiniya –1T and Moiniya–3 electronic reconnaissance satellites is regarded as a programme priority (source: Deputy Commander Russian Space Forces Oleg Gromov speaking at a Parliamentary meeting in November 2005);

- One Geizer data relay satellite launched in 2000;

- Four Globus/Raduga communications satellites placed in geo-stationary orbit between 1999 and 2004. Raduga satellite variants in two sets of geo-stationary orbits are used for real time military communications along with Potok data relay satellites. It is also believed to be a military priority to replace existing Parus communications and navigation satellites with more modern Meridian equipment (source: Deputy Commander Russian Space Forces Oleg Gromov as above); and

- Seven Strela communications satellites placed in Low Earth Orbit in 2001 –2003. An operational constellation requires six working satellites. Multiple Strela 3 satellites are now launched alongside a commercial derivative known as Gonets-D1 and are used for message storage and transmission across the CIS.

Weather satellites

Russian military have access to all weather information they may need from a range of civilian and dual use satellites.

Navigation satellites

The IISS report that four operational Parus military navigation satellites were placed in Low Earth Orbit between 1999 and 2004. All four are required to form an effective constellation for military as well as civilian use, although civilian systems may have been phased out.

A main focus of Russian efforts and expenditure at the moment in both civil and military space is to revive the GLONASS navigational programme which is operating well below maximum effectiveness due to an inadequate number of satellites (11, of which 8 are fully operational) in the present constellation. It has been under development since 1982 and is now intended to compete with GPS and Galileo. A special Federal programme worth Rb 23.6 billion ($842 million) has been set up to this end with the intention of getting the system back on track, hopefully by 2007/2008 although the year 2010 seems more likely. Neither China nor Europe has responded to offers to participate at an equity level in the system. One estimate of GLONASS’s operating costs is Rb 1.5 billion ($53.5 million) per year. China has however become a Galileo participant. India has agreed in principle to loft GLONASS satellites, probably in return for the transfer of cryogenic engine and other technologies.

A2.3.3 Industry

Expenditure

Sources on expenditure, particularly on military programmes are difficult to obtain given that it is difficult to differentiate government expenditure between civil and military application, before accounting for dual-use aspects. The information provided below is sourced from a Russian Federal Space Agency, various Press Reports made in 2006and the Russian Ministry of Defence 2006 Budget Summary.

Funding for military space activities in Russia comes from three main areas.

1) Military budgets;
2) RKA budgets and the commercial activities of RKA constituent firms; and
3) Revenues from the military and civil sale of technology, provision of services (satellite launch, space tourism, sale of imaging etc).

The IISS estimate Russia’s 2006 military budget expenditure at Rb 666 billion ($23.7 billion. About 5 to 10 percent ($1.3 to $2.3 billion) of this may be accounted for by strategic missile forces and other military space activities. At most $1 billion would be directed towards non-missile military space activities such as satellites. Russian military expenditure remains opaque and a breakout would not be practical. However, it is known that the Russian armed forces will receive six new military satellites in 2006 as part of a Rb 106 billion ($3.78 billion) weapons and procurement budget line.

The ESA quotes the RKA as saying that between 2006 and 2015 around $20 billion will be allocated in the form of agency budgets and additional funding for the GLONASS navigation system. This figure, averaged over ten years at $2 billion per year, is significantly larger than the generally quoted budgets of $800 million this year. It will, GLONASS apart, certainly include some element of military satellite provision. RKA constituent organisations will receive elements of this RKA budget, by way of either capital allocation or payment for products and services delivered. Even at such an extended level, Russian space funding compares very poorly with NASA’s $16.4 billions space budget, which is nearly entirely allocated towards civilian programmes.

Commercial revenues are the final key source of funding in Russia. The RKA plans to have a commercial income of around Roubles 130 billions ($4.6 billion over ten years at the October 2005 exchange rate) over the ten year period to 2015. This would add about 22 per cent to the average annual budget for RKA and GLONASS combined. This revenue will arise from satellite launches, support for the International Space Station, space tourism, etc. Satellite launches typically generate $10 to $15 million each and additional payloads can be charged at $6,500 per kilogramme. Eight different launch vehicles and systems are apparently available. Space tourists seem to pay around $20 million per trip, although this rate may decline with competition and greater capacity as the market develops. Various contracted flights to the International Space Station (ISS) and Progress flights are thought to bring in revenues UD$42-50 million per person/flight of which 16 missions are planned from 2008 onwards (four two-person ISS flights and eight progress missions). These revenues are not directly applicable to military space programmes, but must indirectly make their funding easier. In most cases it is impossible to identify the turnover of individual firms from public domain information, but where it is possible (in two cases totalling $174 million at the then rates of exchange rate) this is shown in Table A2.2.

Military space product sales include India's acquisition of cryogenic propulsion technology from Russia for its Geo-synchronous Launch Vehicle (GSLV) programmes. Russian space based military imaging equipment has been sold to its allies for satellite use (e.g. SAR radar to China). No estimates could be obtained of relevant military space sales value.

Employment

It is believed that at least 50,000 (and perhaps as many as 100,000) military personnel are in some way involved in Russia's ballistic missile and military space programmes. There will also be significant civil service and administrative employment.

In the RKA, there is no overall figure for total employment available from the public domain sources we have been able to access and many of its constituent firms and organisations do not provide employment or turnover figures. Using the Nuclear Threat Initiative website (www.nti.org) and Janes Space Directory 2006, approximately 83,500 jobs amongst 10 large organisations have been identified. As an approximation, at least 100,000 further people are employed by RAK constituent organisations. However, these RAK elements are often not exclusively concerned with space technology, let alone military space technology. For example, NKO Saturn is principally involved in the manufacture of jet engines.

Table A2.2 below provides a summary of the employment and turnover amongst some constituent parts of the RAK network (Note: This table is incomplete and serves as a guide to the companies involved in the military related sector of the Russian space industry, those companies where no information was available have been omitted).

Table A2.2: Turnover and Number of Employees in Constituent RAK Network Companies			
Company Name	**Annual Turnover $**	**Employees**	**Data Source**
KB Kolomna (Design Bureau of Machinebuilding/Konstruktorskoe byuro mashinostroeniya, KBM)	$150 million (2002)	3,200	www.nti.org
KB Machinostroenye	$24.4 million (2000)		www.nti.org
Khrunichev State Research and Production Space Centre	-	Approx 20,000 at all locations	JSD (2006)
NPO Kompozit	-	Approx 7,500	JSD (2006)
NPO Molniya	-	Approx 2,800	JSD (2006)
NPO Soyuz Subsidiary - KB Khimmach	-	Approx 3,600	JSD (2006)
NPO Saturn/Lyulka	-	Employees 21,000 (majority employed on non-space activities)	JSD (2006)
RKK Energia	-	22,000, with 1,000 permanently sited at Baikonur	JSD (2006)
NPO Tekhnomash	-	8,500 about half of whom are graduate engineers.	JSD (2006)
TsAGI (Tsentralny Aero-Girodinamichesky Institut)	-	5,900	JSD (2006)
Total Identified Employment:		**83,500**	
Source: JSD (2006): Jane's Space Directory 2006			

Summary

The Russian Space Agency has been frustrated in many of its activities by constraints on funding. The 1990s were characterised by a decreased cash flow but this had a positive effect in forcing RKA to look outside the state for additional funding. This led it to the commercial space launch market and space tourism. RKA managed to operate the Mir space station well beyond its planned lifetime and to contribute to the International Space Station as well as flying additional Soyuz and Progress missions.

By 2006, the funding situation has rebounded, offering more favourable prospects. The Duma was able to approve a budget of Rb 305 billions (approx $11bn) for the Space Agency during the period 2006-15 with overall space expenditure of Rb 425 billions for the same period. The 2006 RKA budget was set at Rb 25 billion ($900m), which was a 33 per cent increase over that for 2005. The 10-year budget provision allows for a 5-10 per cent increase per year. This should be sufficient to provide the Agency with a stable financial base, but it also plans to have a commercial income of around Rb 130 billion ($4.6 billion) over the same period.

Some space activities (including the Glonass) navigation system, which is overseen by the Ministry of Defence fall outside the scope of the Space Agency Budget. The Russian Defence Budget for 2006 refers to an allocation of around Rb 367 million ($13.1 billion) for work undertaken by the Federal Space Agency for Glonass or work on launches/launchers. It is likely that Glonass expenditure is covered within the Rb 120 billion ($4.2 billion) difference between the Agency allocation and overall space-related expenditure in the ten-year plan.

A2.4 India

A2.4.1 Overview[100]

India has an ambitious, fast growing and effective space programme that started in 1962. By 1972, a separate Department of Space (DOS) was set up to oversee the Indian Space Research Organisation (ISRO) and certain other bodies that between them embrace the whole of the Indian space programme. Civilian and military aspects of the satellite programme are in practice intermingled and India has an independently managed nuclear ballistic missile capability, with recent economic growth providing funding for both military and civil space applications. Since the programme began, numerous satellites have been put into both geo-stationary and polar orbits using liquid and solid fuelled rocket systems. India has co-operated with foreign states (especially Russia and Israel) and other international organisations to provide launch services, purchase access to services and acquire technology.

India uses military space technology to gain regional intelligence and project regional power, especially with regard to tensions with both Pakistan and China. Its ballistic weapons provide a strategic defensive capacity and its military space programme also boost its military prestige along with its growing economic strength. The huge size of the sub-continent makes its armed forces highly dependent upon satellite communications, which it has developed to a high level, while it also has developed considerable skills in space based military reconnaissance.

The Indian Space Research Organisation (ISRO) employs some 20,000 people with a 2005-2006 budget of around $700 million (but spent $939 million in the year to June 2006). It has an extensive network of research, test, launch and tracking sites. A subsidiary firm, Amtrix Corporation Ltd, has responsibility for commercial marketing of ISRO services and products. Under the direct control of the Department of Space are a number of other organisations such as the: National Remote Sensing Agency (NRSA), Regional Remote Sensing Service Centres (RRSSC), Physical Research Laboratory Ahmedabad, and National Mesosphere/Stratosphere Troposphere Radar Facility Gadanki, Tirupati.

Overlaps between civil and military programmes are common in India. It has developed military satellite technology by adding military applications onto civil payloads and then making use of its IT capabilities to process the resulting information. It has in the past been censored or sanctioned by the US when such activities became too obvious or it was believed that technology transfer from Russia carried potential military and political threats.

100 Sources: ISRO and Jane's Space Directory 2006

A2.4.2 Programmes

Relevant programmes include:

- ***Launch systems***: India has a reasonable track record with both liquid and solid fuel rockets and has developed the GSLV and the Polar Synchronous Launch Vehicle (PSLV) for launch of the INSAT series of communications satellites. There have been some failures of the GSLV strap-on boosters and cryogenic motor upper stages. ISRO have also been working to develop a scram-jet based re-useable launch vehicle which if successful will provide economic and technological advantages.

- ***Reconnaissance Satellites***: Reconnaissance satellites, combined with the ability to stereoscopically combine and process electronically downloaded images, some of which are at resolutions as fine as 1 metre, are a developed feature of Indian military technology. These are added onto civil systems, for instance, the Technology Experimental Satellite (TES) launched in 2001 and now degrading offered one metre resolution for both military and civil users. In 2003, Resourcesat-1 (a dual use satellite) and two Cartosat satellites were launched (offering stereoscopic 2.5 metre resolution) officially for mapping and development purposes. These will form an essential part of the Army's first official Satellite Based Surveillance and Reconnaissance System intended for completion during 2007-2008.

- ***Electronic and Signals Intelligence Satellites***: India has sufficient capacity to monitor appropriate regional opposing forces using sensors and relays attached to civilian payloads.

- ***Communications Satellites***: The Indian military satellite communications system is based upon the INSAT constellation and offers extensive data, e-mail and voice traffic capacities at a strategic and tactical level at both static and field mobile application levels. An exclusively military communications satellite is said to be in the pipeline for late 2007.

- ***Weather satellites***: Numerous civilian satellite programmes provide weather monitoring and these are accessed as appropriate by the armed forces.

- ***Navigation satellites***: India and Russia have collaborative space programmes in place, one of which relates to civil and military use of the Russian GLONASS navigation system. In 2005 the two countries signed an agreement on technology safeguards, joint development and operation and use of Russia's GLONASS global navigation satellite system. India has a crucial role not only in the renovation of the GLONASS system, but also envisages launching GLONASS satellites using Indian space vehicles. India also participates in Galileo.

A2.4.3 Industry

Expenditure

The financial costs of the Indian military space programme are far below the levels found in China and can be estimated with rather more confidence. The main elements are to be found in military and civil budgets together with revenues from satellite launches etc and off budget foreign purchases. Indian military expenditure in 2005 was around $22 billion (IISS), of which around 5% or $1 billion (€800 million) is associated with the maintenance of ballistic missile and military space programmes, although no reliable breakthrough is available.

Apart from some funding of DOS centres such as those for remote sensing, nearly all space expenditure not funded by military budgets is channelled through the ISRO. Private sector involvement within India in military space is negligible. India's ISRO space budget has grown by 91 per cent in the four years up to 2001 and high rates of growth are expected to continue. Major areas of growth are in satellite operations and space applications, each of which greatly benefits local and regional development.

ISRO publishes detailed accounts, which split actual and budgeted expenditure down into a number of components. The most recent figures from ISRO are for the year to end June 2006 and these are presented in Table A2.3 below. The 2005-2006 estimate would correspond approximately to a sum around $700 million (€560 million). Perhaps one third of this funding might be allocated to military applications, but no breakdowns are available. ISRO figures for actual expenditure for the year end at June 2006 were substantially above budget at 4323.2 core rupees or approximately $939 million/€751 million (at an exchange rate of 46 rupees/$) as broken down in Table A2.3 below.

Table A2.3: Indian Space Research Organisation Expenditure by Activity

Activity	**Estimated Percentage of Total Expenditure**
Launch Vehicle Development	~52% ($585 million)
Satellite Development	~18% ($169 million)
Space applications	~10% ($94 million)
Science Applications	~6% ($56 million)
INSAT Satellite Programme	~11% ($103 million)
Administration and Direction	~3% ($28 million)
Total	**100% ($939 million)**

Source: ISRO (2006)

ISRO

ISRO functions as an Agency of the Department of Space (DOS). The DOS has played a leading role in determining the balance between scientific and commercial space activities and the application of space capabilities for defence and national security.

The ISRO undertakes design, development, production and operation of satellites, launch vehicles and ground stations for satellite-based communications; resources survey and meteorological services. The organization has responsibility for the implementation of research, industrial and commercial space activities under the ultimate control of the Department of Space. In particular, ISRO undertakes design and development of the Polar Satellite Launch Vehicle for the launch of the INSAT series of communications satellites and is also specifically responsible for the operation of satellites for telecommunication, TV broadcasting, meteorology and disaster management.

Much of the Organization's work overlaps with developmental and production work undertaken within the defence community. There is almost certainly interplay between ISRO and other organizations undertaking defence related programmes within the national defence industrial base. ISRO subsidiary organisations include:

- Vikram Sarabhal Space Centre Trivandrum (Thiruvananthapuram);
- Liquid Propulsion Systems Centre (LPSC) Thiruvananthapuram;
- ISRO Inertial Systems Unit, Thiruvananthapuram;
- ISRO Satellite Centre .Bangalore;
- ISRO Space Applications Centre, Ahmedabad;
- ISRO Telemetry, Tracking and Command Network (ISTRAC);
- ISRO Balasore Test Range;
- Orissa; and
- ISRO Development and Education Communications Unit.

North Eastern-Space Applications Center (NE-SAC)

This stand-alone organisation is supported by ISRO and the North Eastern Council. It is concerned with the promotion of space technology for the benefit of the regional population and with space science research within the region and natural resources management.

Antrix Corporation Ltd

This commercial organisation is responsible for marketing space products and services available from its parent organisation, ISRO. These products include satellite systems and sub-systems (telecommunications, remote sensing and scientific) and services marketed include tracking telemetry and control, launch services and value added applications based on satellite applications.

Employment

Total employment in the Indian military space programmes is hard to estimate. ISRO figures suggest that, including its subsidiaries, the organisation employs around 20,000 persons, of which only a proportion (perhaps 30 to 40%) will be involved in military space activity. The armed forces have an estimated 1.3 million serving personnel. Perhaps 5% or say 50,000 of these (our estimate) may be in some way involved with military space activities in either the missile areas or in C4ISR[101] areas such as communications, tracking, imaging etc. There are only a few other Indian organisations, outside the armed forces involved in defence space manufacturing and services. .

The Department of Space employs numerous civil servants and certain of its subsidiary organisations such as the national remote sensing agency may employ a few thousand more. The latest ISRO figures indicate approved staff figures of around 16,000 persons, of which around 11,000 are employed in science and technology and 5,000 in administration.

Summary

India possesses a highly sophisticated and very well educated base of scientists and technologists, many educated to PhD level and with an excellent command of English or other European languages. It is therefore unsurprising that its military space programme is particularly strong in sensing, communications and image resolution. It has been willing to supplement its national skills base by buying in technology and know how from Israel (SAR radars and complex image resolution and mapping in particular) and Russia (cryogenic engines and navigational systems). In return, it offers access to funds or its established satellite launch programme if it is a net purchaser of services.

India's growing economy and regional aspirations are likely to drive its military space programme forwards, although the USA will probably continue to keep a watchful eye on technology transfer that it may regard as unhelpful or destabilising.

[101] C4ISR is the acronym for Command, Control, Communication, Computers, Intelligence, Surveillance and Reconnaissance.

ANNEX 3:

DEVELOPMENT OF DEMAND SCENARIOS

A3. DEVELOPMENT OF DEMAND SCENARIOS

A3.1 Overview

The Project Specification requires that demand scenarios are compiled for the next 15 years. The full demand scenarios will therefore cover the period from 2007 to 2021.

Possible demand scenarios are discussed below and consideration is given to:

- the future worldwide space commercial market, including:
  - space application market forecasts; and
  - commercial space transportation forecasts (number of launches foreseeable, for the different categories of satellites, per market);
- the future European civil institutional market;
- the future European defence institutional market; and
- the use of constellations of satellites vs big platforms.

In developing these scenarios, consideration has been given to a number of sources, including Euroconsult (2004, 2005a and 2005b), ASD-Eurospace (2006), AST & COMSTAC (2006) and OECD (2004). Most of these sources provide an indication of the predicted markets over the next ten years (from the date of publication). These are mostly ‘business-as-usual’ scenarios and are based on a bottom-up analysis of existing orders, predicted replacements of in-orbit satellites and general indications of likely demand, under a continuation of current socio-economic and political conditions. However, the last of these sources, OECD (2004), provides scenarios for the space industry to 2030 based on possible geopolitical developments, socio-economic developments, developments related to energy and the environment, and technology developments. The three scenarios can be summarised as:

- ***Scenario 1: Smooth sailing*** – a relatively optimistic scenario. This is largely a peaceful world, with the growth of global trade and the internationalisation of production worldwide. Co-operation among nations contributes to the solution of world problems. However, organised crime and terrorism continues to be active, and the environment continues to deteriorate (although less than in other scenarios);
- ***Scenario 2: Back to the future*** – a middle-of-the-road scenario. Three major economic powers dominate the world: the US, Europe and China. The economic power of the US and Europe are gradually weakened and they choose to strengthen ties with each other and to coordinate military forces. This gradually leads to a bi-polar world, where rivalry between Western and Eastern blocs dominates the policy agenda; and
- ***Scenario 3: Stormy weather*** – a relatively pessimistic scenario. Strong disagreements among major powers lead to a gradual erosion of international institutions. Economic conditions deteriorate as the world reverts to protectionism. Growing social and ecological problems are largely ignored.

As OECD (2004) notes, the construction of scenarios is somewhat arbitrary and other possibilities may be imagined. Scenarios represent possible, rather than likely, futures and they provide a means of testing how different geopolitical, social and economic conditions may affect the space industry.

This Annex discusses both the business-as-usual scenarios and the OECD scenarios for each of the key markets. These enable scenarios for the key variables in each market to be developed, and quantified/qualified as appropriate, and other variables are identified, for which the details will be developed once the main scenarios have been agreed with the Commission.

The business-as-usual scenario presents a quantified forecast, whilst the OECD scenarios provide qualitative forecasts. It is likely that the business-as-usual scenario lies somewhere within the range suggested by OECD (2004), however it is not directly correlated with a specific OECD scenario. In the scenarios developed in this Section, the business-as-usual scenario is incorporated, generally as the middle forecast, with a higher and a lower demand forecast either side. However, it cannot be said that OECD *Scenario 2: Back to the Future* (as presented in OECD (2004)) is the same as the business-as-usual scenario as the former suggests certain political developments. Instead, in this Report, the OECD scenarios have been used as an initial framework, to suggest variables such as the level of military action, the degree of international cooperation, general economic conditions, etc. Some variations have been suggested where these are supported by other sources, or in order to provide a greater range for future demand. It should also be noted that the suggested management structures under the OECD scenarios have not been considered at this stage, as this would pre-empt the later tasks in this study.

A3.2 The Future Worldwide Space Commercial Market

A3.2.1 Business-as-Usual Scenario

Overall Market Demand

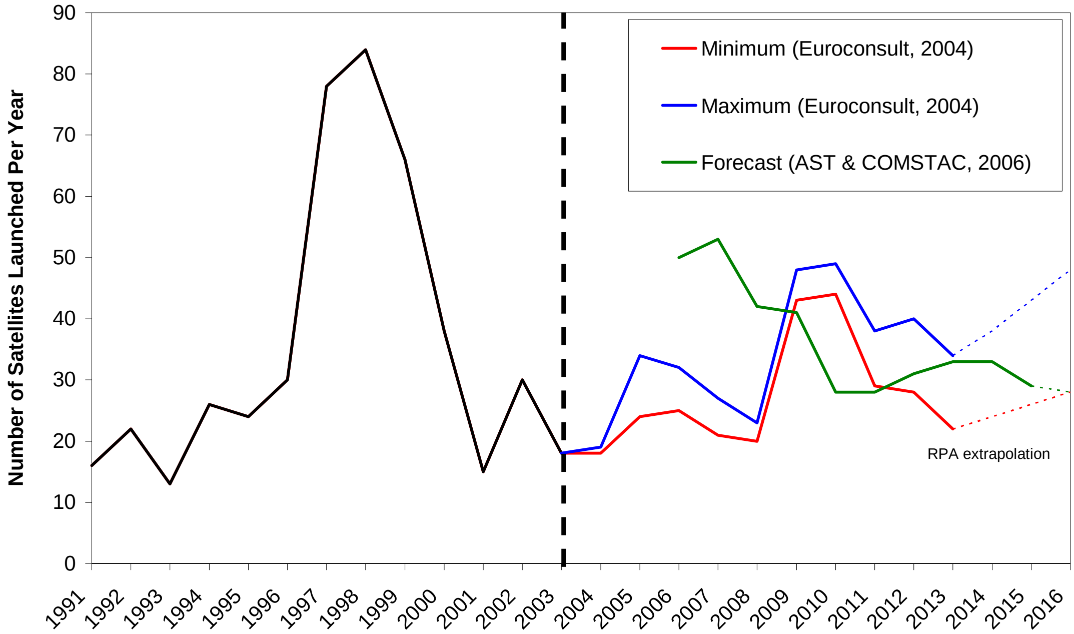
Growth in global demand for commercial satellites over the next five years is likely to be the slowest of the three markets (commercial, civil and military). This reflects the cyclical nature of investment in geostationary satellite systems (the dominant type) as well as the improved productivity of geostationary communications satellites, permitting the expansion of satellite services with a limited number of satellites (Euroconsult, 2004).

Although ASD-Eurospace (2006) suggests that a trend towards recovery for the commercial satellite market can be foreseen, levels of demand will be lower than those experienced in the late 1990. It is expected that regional satellite service providers, particularly in the Asia-Pacific region will provide the orders for new satellites. This number, however, may be less than expected given the low rate of replenishment, both on the regional and global arenas (Mitsis, 2005).

In order to develop a business-as-usual scenario, consideration has been given to predictions by Euroconsult (2004) and AST & COMSTAC (2006), both of which are based on bottom-up analyses of commercial demand.

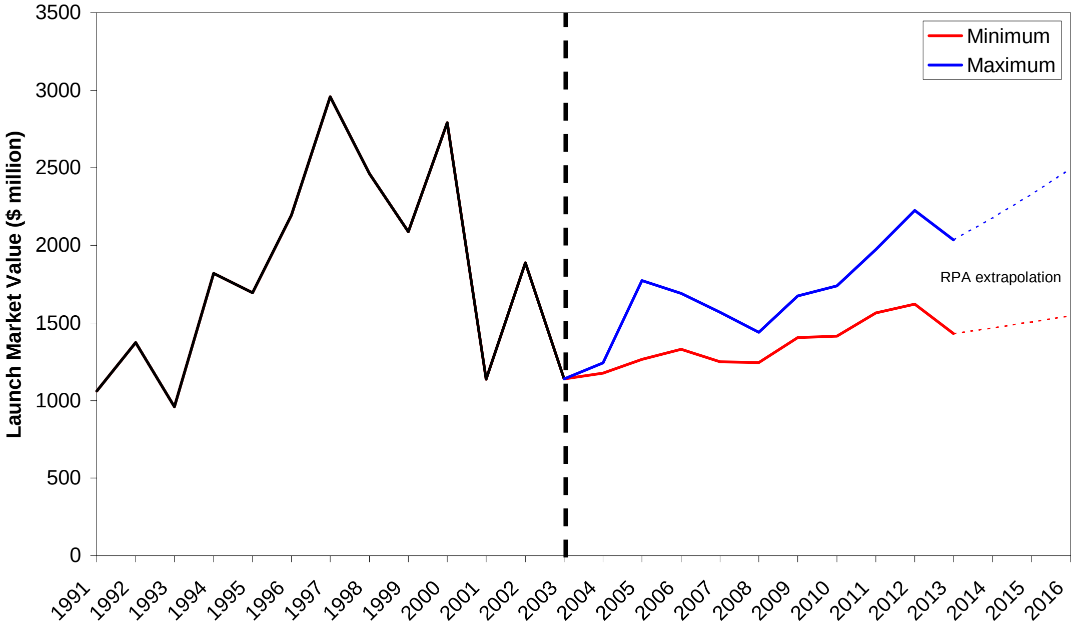
Euroconsult (2004) predicts a total of 274-344 satellites to be launched over the period 2004-2013; this relates to an average growth rate of 3-5% for GEO commercial satellites (AST & COMSTAC (2006) indicates a rate of 4% from 2006-2015). Trends in LEO commercial satellites are more difficult to summarise as the predicted number of annual launches fluctuates from year to year. The total number of satellites predicted for launch is shown in Figure A3.1, based on Euroconsult (2004) and AST & COMSTAC (2006). It can be seen that there is considerable variation between the two predictions in the short-term, but greater convergence towards the end of the forecast period.

Figure A3.1: Forecasts for the Number of Commercial Satellites to be Launched Worldwide 2004-2016
(source: Euroconsult (2004) and AST & COMSTAC (2006))



The market value of launches is illustrated in Figure A3.2, with Euroconsult (2004) predictions for 2004-2013 extrapolated at an average rate of 3%-7% for 2014-2016 for the minimum and maximum forecasts respectively. It is noted that the higher rate may be an overestimate when considering the relative growth of the institutional markets.

Figure A3.2: Forecasts from 2004-2016 for the Global Commercial Launch Market Value
(source: Euroconsult, 2004)



The launch market value is based on the assumptions shown in Tables A3.1 to A3.3 regarding the mass of GEO and LEO satellites and the relative launch costs. Table A3.1 includes AST & COMSTAC (2006) assumptions on GEO satellite mass; however, these are not directly comparable as different category boundaries have been used[102]. Over the past 20 years, the average mass of commercial satellites launched to GEO has increased significantly, from about 1,500 kg in the mid-1980s, to a record of 3,700kg in 2002. Growth in mass should stabilise at around 4,000kg as more satellites are equipped with new technologies which permit increased productivity while saving weight.

Table A3.1: Launch Mass of Commercial GEO Satellites

	Euroconsult (2004)				AST & COMSTAC (2006)	
Launch Mass (kg)	**Observed**		**Planned**		**Launch Mass (kg)**	**Planned**
	1994-98	**1999-03**	**2004-08**	**2009-13**		**2006-15**
					>5,400	21%
>4,700	0%	9%	27%	27%	4,200-5,400	39%
3,700-4,700	7%	24%	28%	28%	2,200-4,200	29%
2,700-3,700	43%	40%	17%	15%		
1,700-2,700	36%	17%	18%	20%	<2,200	11%
<1,700	14%	10%	10%	10%		

Table A3.2: Average Launch Mass of Commercial LEO satellites for Earth Observation

1990-2003 (Observed)	2004-07 (Planned)	2008-13 (Planned)
600kg	450kg	600kg

Source: Euroconsult (2004)

102 The 2006 forecast is based on the US industry, and suggests that around 60% of satellites to be launched will be in the two largest mass classes (i.e. >4,200 kg). However, AST & COMSTAC (2006) note that non-US respondents (i.e. Arianespace and Mitsubishi Heavy Industries) predict that less than 50% of the total demand would be in the two largest mass categories.

There is also a market for smaller GEO satellites, which may be used to (Euroconsult, 2004):

- replace existing capacity with similar capacity;
- mitigate market risk when entering a new market;
- to augment existing capacity with additional capacity; and
- provide a means for entering the satellite business in a market with a limited initial size.

Future launch prices have been estimated on the basis of historical price data, and assumptions vary by orbit, depending on the market size and on competition intensity by type of orbit, as shown in Table A3.3. Euroconsult (2004) suggests that decreasing prices generated by more competition could be expected, especially in the launch market for commercial GEO satellites. Other reasons for a possible decline in launching costs include the use of multiple payload launch capability, split co-manifesting of payloads onto a single launch vehicle and efforts to reduce the launch vehicle to payload cost ratio. In the current competitive environment, cost savings should exert downward pressure on launching contract prices. However, lower launching prices are unlikely to generate much additional revenue as the demand for launching services tends to be rather inelastic (OECD, 2004).

Table A3.3: Assumptions on Specific Launch Prices

GEO/HEO	MEO	LEO
A function (exponential regression) was derived from a sample of historical price data points.	Average constant price of \$15,000/kg	Average constant price of \$8,000/kg for telecommunications and \$13,000/kg for other applications

Source: Euroconsult (2004)

Applications and Orbits

Table A3.4 (overleaf) sets out Euroconsult's (2004) forecast of the demand for commercial satellites by application and orbit. This is dominated by GEO satellites for FSS and BSS (58%-61%), followed by LEO satellites for MSS (19%-23%). Other applications account for a relatively small proportion of the demand.

Recovery in GEO satellite demand should occur by the end of the decade, with a new phase of growth likely, assuming that two market factors will act as mass drivers (Euroconsult, 2004):

- the replacement of existing capacity; and
- the introduction of new satellite services targeting mass markets.

However, it is possible that not all satellites are replaced or that two satellites are replaced by one larger satellite (Euroconsult, 2004).

Table A3.4: Forecast of Number of Commercial Satellites by Service by Orbit 2007-2013

			2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Total**	**% of Market**
Demand-driven satellite services											
FSS & BSS	GEO	MIN	19	17	17	17	19	19	18	**126**	61%
		MAX	22	18	20	21	24	23	22	**150**	58%
Supply-driven satellite services											
MSS	LEO	MIN	2	0	22	22	2	0	0	**48**	23%
		MAX	2	0	22	22	4	0	0	**50**	19%
	MEO	MIN	0	0	0	0	6	6	0	**12**	6%
		MAX	3	0	0	0	6	11	5	**25**	10%
	GEO	MIN	0	0	1	1	0	0	1	**3**	1%
		MAX	0	0	1	2	0	1	2	**6**	2%
DAB	GEO & HEO	MIN	0	1	1	1	1	1	1	**6**	3%
		MAX	0	2	2	1	1	2	2	**10**	4%
Ka-band & other	GEO	MIN	0	1	1	1	0	1	2	**6**	3%
		MAX	0	2	1	1	1	1	2	**8**	3%
Earth Observ.	LEO	MIN	0	1	1	2	1	1	0	**6**	3%
		MAX	0	1	2	2	2	2	1	**10**	4%
Total		MIN	**21**	**20**	**43**	**44**	**29**	**28**	**22**	**207**	100%
		MAX	**27**	**23**	**48**	**49**	**38**	**40**	**34**	**259**	100%

Source: Euroconsult (2004)

In the medium-term, the uptake of new services such as ethnic and thematic television channels, high definition TV, DAB, and entertainment services, and VSAT corporate networks for small and medium companies and home offices should compensate for the decrease in traditional voice and data traffic on satellites. GEO satellites are already significant players on the Internet market because of their broadcast and multicast advantage. In the longer term, the availability of broadband satellite services could allow the economic introduction of new mass services not yet anticipated (Euroconsult, 2004).

Whilst there are currently no commercial MEO satellite systems in operation, the forecast retains this as a possibility, perhaps for broadband services. Euroconsult (2004) assumes that a new generation of LEO satellite systems might be launched at the end of the decade based on the intrinsic efficiency of LEO satellites coupled with innovative spacecraft and payload designs that would greatly improve the productivity of such satellites. The LEO forecast allows for the replacement of Globalstar or the launch of a new constellation by SES/Orbcomm.

With regard to Earth Observation, Euroconsult (2004) anticipates that 8 to 12 privately financed satellites will be launched over the decade to ensure continuity of existing systems. The maximum scenario assumes the development of a competitive private industry along with the development of satellite-based inputs in GIS (Euroconsult, 2004).

Table A3.5 summarises and compares the forecasts of Euroconsult and AST & COMSTAC by orbit. Whilst GEO forecasts are broadly similar, there are significant short-term differences in non-GEO forecasts. AST & COMSTAC (2006) explains that the build-up of near-term launches reflects several trends unique to the non-GEO market:

- an increase in countries, companies and international non-profit organisations interested in deploying diverse satellites;

- the availability of low-cost launch vehicles to fit increasingly capable small mass satellites;

- delays in funding which have caused manifests to back up; and

- the confluence of planned replacements for commercial remote sensing and telecommunications satellites.

Table A3.5: Total Predicted Number of Satellites by Orbit

	Year	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
GEO	Min (a)	18	19	20	19	19	20	20	20	21	22	*23*	*23*	*24*
	Max (a)	19	23	23	22	22	24	25	26	27	28	*29*	*31*	*33*
	(b)			23	34	17	18	19	20	22	22	23	20	*21*
Non-GEO	Min (a)	0	5	5	2	1	23	24	9	7	0	*0*	*0*	*0*
	Max (a)	0	11	9	5	1	24	24	12	13	6	*5*	*3*	*3*
	(b)			27	29	25	23	9	8	9	11	10	9	*8*

Source: a = Euroconsult (2004); b = AST & COMSTAC (2006)

Table A3.6 illustrates the launch demand for GEO satellites, determined by adjusting satellite demand by the number of satellites projected to be launched together, termed 'dual-manifest' launch. Currently only the Ariane 5 has the capability to dual-manifest commercial GEO satellites. Dual-manifesting is cost-effective when the market demand is high and companies have a large market share; however, when lower numbers of satellites are being launched this approach is less cost-effective.

Table A3.6: Commercial GEO Launch Demand Forecast

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**	**Ave.**
Satellite Demand	23	24	17	18	19	20	22	22	23	20	208	20.8
Dual Launch Forecast	5	4	4	4	4	4	4	4	4	4	41	4.1
Launch Demand	18	20	13	14	15	16	18	18	19	16	167	16.7

Source: AST & COMSTAC (2006)

The growth of satellite developments efforts in countries without indigenous launch capabilities has generated steady demand for commercial launch services that has outpaced demand from other markets, including telecommunications and commercial remote sensing, over the last few years. Most of these missions involve small satellites on modest budgets, so the demand leans towards low-cost, small launch vehicles. In the past few years, science or technology demonstration payloads have been launched commercially for operators in a number of countries, including China, France, Italy, Nigeria, Saudi Arabia, Taiwan, Turkey and the UK (AST & COMSTAC, 2006).

Level of Cooperation

Euroconsult (2004) suggests that satellite operators have a few options to remain attractive to investors and capital providers. These are to:

- pursue the consolidation of the industry to maximise economies of scale and get access to new markets, when it makes sense according to the competitive positioning of the candidates for a transaction;

- search for distinctive competitive advantages with high value for the clients, and the clients of the clients. New technologies on board the satellites and on the ground permit to introduce new services, to address new clients or to provide existing services more cost effectively.

To maximise the advantages of satellites, Euroconsult (2005b) suggest that the industry still needs deregulation (of capital markets, of service provision), technology advances (of the satellite, of the ground hardware and software), and of course, economic growth to ensure solvable markets.

A3.2.2 The OECD Scenarios

In relation to the commercial market, the OECD scenarios suggest the following:

- ***Scenario 1: Smooth sailing*** - In a peaceful world scenario, a more open environment for commercial space is created and the space infrastructure that supports trade and commerce is significantly upgraded. The space industry undertakes broad restructuring at the global level, leading to significantly reduced costs of access to space and the development of new services that can fully exploit the advantages of space over terrestrial alternatives. Telecommunications, Earth observation and navigation infrastructures are expanded so as to support the development of global systems and, where relevant, compete successfully with terrestrial networks;

- ***Scenario 2: Back to the future*** - Regions tend to pursue their own strategic interests and commercial space activities tend to develop more slowly than in the first scenario. A limited but real return to protectionism in the space sector is encouraged by security concerns so that each region develops commercial applications to meet its own strategy. Restrictions on information flows (*e.g.* Internet regulations, operator licensing) negatively affect the telecommunications sector and the broadcast industry (*e.g.* television via satellite) faces strong regional competition from cable operators. The use of space-based navigation systems is widespread for all forms of transport. A new commercial sector, suborbital space tourism, sees some limited development. Semi-private space firms further integrate their activities and take advantage of higher military budgets to develop dual-use applications under public-private partnerships.
- ***Scenario 3: Stormy weather*** - Increased hostilities have a deleterious effect on economic conditions and market fragmentation. Protectionism tends to be quite strong, limiting technology transfers and export possibilities. Some selected lucrative export markets for space products and services remain open, as a

growing number of countries are keen to build a space capability and to acquire the necessary technology from major space powers. Such powers agree to do so for selected countries for strategic reasons and to extend their regional influence. Private investment in space is cut back, as high-risk investment opportunities requiring the raising of large up-front capital are the first to be postponed when economic conditions are depressed. Strong regional barriers to information have very damaging impacts on telecommunications services (*e.g.* television via satellite, Internet). Suborbital space tourism develops more slowly than in scenario 2, amid strong international tensions. The relative progress in space technologies, due to the high priority accorded to military space, gives space operators an edge over their terrestrial competitors in some cases (*e.g.* surveillance systems). This helps commercial providers of space-based services to maintain revenues in a depressed market. However, space systems in direct competition with terrestrial alternatives (*e.g.* cable operators) suffer major losses of revenues, as markets become increasingly fragmented.

A3.2.3 Scenario Development

Key Variables

There are three driving factors for demand in the global commercial space markets:

- global economic conditions, including the potential for new markets in developing countries;
- technological development; and
- competition from outside of the space industry.

Possible scenarios for global economic conditions are summarised by the OECD scenarios, and can be characterised as a percentage increase in the commercial space market. There are strong indications that the market is cyclical, and that the market is starting to recover from a low point, therefore the most likely scenarios are varying degrees of improvements in the market. However, as a worst case, it should be assumed that the market could decline and, against a background of instability and market sensitivity, wide margins may be necessary. Therefore, the following scenarios are suggested:

- an annual decrease of 5%;
- an annual increase of 4% to reflect current levels; and
- an annual increase of 7% to reflect the most optimistic growth conditions across all three markets in recent years (military).

It is noted that these linear trends do not reflect the cyclical nature of the market experienced to date. It is expected that as the demand models are developed, the cyclical nature will be taken into account (unless other factors suggest otherwise) and these will represent annual averages.

The degree of technological development will affect the efficiency of the commercial space industry and thus its ability to meet the global demand. Under the OECD scenarios, different socio-economic conditions suggest different levels of technological development, such as:

- high (as a result of institutional investment);
- medium/high (as a result of good economic conditions); and
- medium (as a result of poor economic conditions, but institutional military investment).

There seems to be no realistic scenario under which technological development would be low or non-existent.

Finally, the level of competition with terrestrial competitors will affect the overall demand for space products and services, but may also favour some applications over others as well as affect profitability. As for technological developments, competition from outside the space industry is likely to vary between medium and high, but may affect telecommunication applications, Earth observation, navigation or any combination of these, thus giving a number of combinations.

Other Variables

Other variables are likely to be influenced by the driving factors; for example:

- global economic conditions may affect:
  - the degree of consolidation amongst companies (which in turn may affect demand and costs);
  - degree of free trade vs. protectionism;
  - potential for institutional customers to use commercial procurement;

- the degree of technological development may affect:
  - the average mass of satellites launched (i.e. large vs small);
  - the number of dual-manifest launches;
  - cost of access to space; and

- level of competition from terrestrial competitors may affect which applications are promoted and which decline.

These are likely to be influenced by developments in other markets and will be considered in more detail once agreement has been reached on the key characteristics of the demand scenarios to be taken forward.

A3.3 The Future European Civil Institutional Market

A3.3.1 Business-as-Usual Scenario

Overall Market Value

World civil institutional spending is expected to grow between 2% and 4% annually, driven by the US space programme and Asian countries (Euroconsult, 2005a). There is little expectation of strong growth or decline in the European civil institutional market; sources suggest a stable market (ASD-Eurospace, 2006) at current levels of growth (Euroconsult, 2005b).

The number of satellites to be launched over the decade for institutional civil customers, under a business-as-usual scenario predicted by Euroconsult (2004), has been established on the basis of the satellite programmes currently planned by government agencies, assuming the continuation of some programmes through follow-on satellites and the launch of new satellites by governments which are already operating satellites.

Figure A3.3 (overleaf) indicates the predicted launch market value, number and mass of Western European civil satellites forecast by Euroconsult over the period 2004-2013. These data do not provide an obvious trend from which to extrapolate predictions for a further three years (in line with 2007-2016 timeframe being considered here). The total number of civil satellites predicted for launch during the period 2004-2013 is estimated at 96-109 in Western Europe, out of a total of 357-397 globally. This equates to an average of 10-11 per year. The predicted launch market value ranges from €1,232-€1,257 million, and the total mass is 80-84 tonnes. These are based on assumptions set out in Tables A3.7 and A3.8.

Table A3.7: Assumptions on Satellite Launch Mass

Application	1990-2003 (observed)	2004-2008 (planned)	2009-2013 (planned)
Meteorology LEO	1,270 kg	1,950 kg	3,000 kg
Meteorology GEO	1,520 kg	2,100 kg	2,100 kg
Earth observation LEO	2,000 kg	1,100 kg	1,100 kg
Telecom non-GEO	800 kg	600 kg	600 kg

Source: Euroconsult (2004)

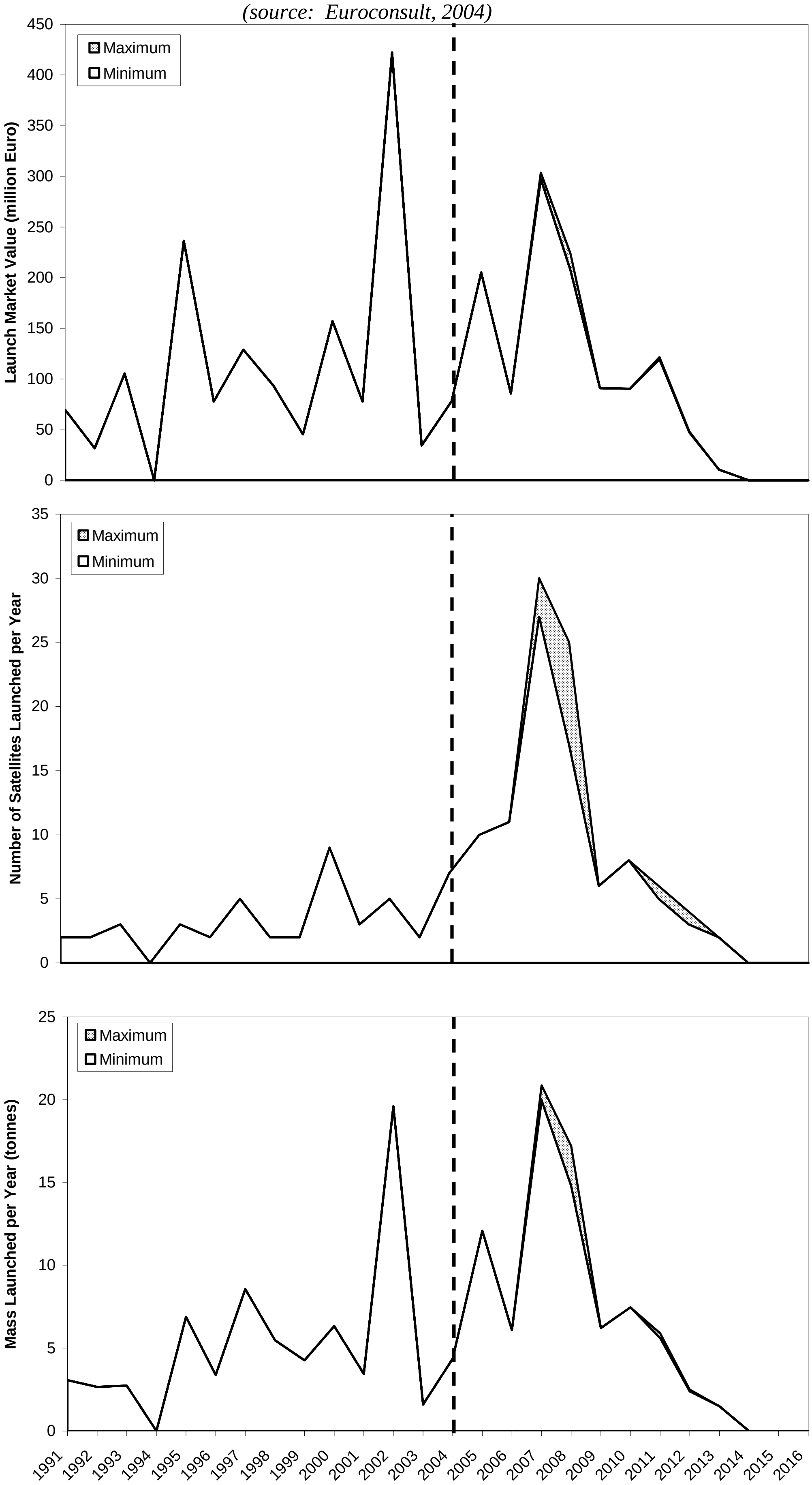
Table A3.8: Assumptions on Specific Launch Prices

GEO/HEO	MEO	LEO
A function (exponential regression) has been established for historical and future commercial satellites. This has adapted for institutions as it is assumed that launch prices will not decrease as much for institutions as for commercial customers.	Average constant price of $18,000/kg	Average constant price of $8,000/kg for launch mass less than 2,000 kg Average constant price of $18,000/kg for launch mass greater than 2,000 kg

Source: Euroconsult (2004)

Figure A3.3: Predicted Western European Civil Institutional Space Market for 2004-2013

(source: Euroconsult, 2004)

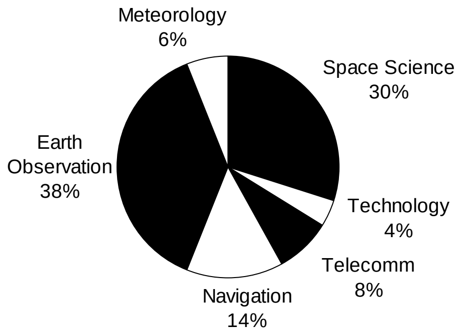


Applications

European civil institutional funding in 2004 focused on launchers, accounting for 20% of civil institutional expenses, followed by human spaceflight (17%), navigation (14%) and Earth observation (11%). However, budgets dedicated to launcher R&D are declining following the completion of its launcher programme with the development of Ariane 5. Key applications over 2004-2013 in Europe are expected to be Earth observation (GMES), telecommunications ('Digital Divide'), and navigation (Galileo), for which budgetary growth of 4.3% is predicted.

Figure A3.4 illustrates the proportion of civil satellites by application to be launched worldwide between 2005 and 2010. At a global level, the highest levels of demand are expected to be for Earth observation satellites, and this is also at the forefront of national activities in Germany, Italy and the UK as well as the core of the activities of the emerging countries in space, together with space science. However, institutional investments are quite stable at a world level, and the increased demand from emerging countries is unlikely to lead to major budget increases since many of them will consist of small, low-cost satellites (Euroconsult, 2005a).

Figure A3.4: Institutional Civil Satellites to be Launched Worldwide by Application 2005-2010
(source: Euroconsult, 2005a)



Emerging European civil markets include Poland, the Czech Republic, Hungary, Romania and Turkey. Euroconsult (2005a) suggest that these newcomers will focus on programmes from which they can get direct benefits, principally telecommunications (TV broadcasting, telemedicine, etc) and observation (natural resources management, security and defence). Science and technology programmes may also be a particular point of interest in order to develop local industrial/technological capabilities.

Major meteorology initiatives are being led by civil and military US agencies and European civil institutions, with the objective to upgrade existing systems and to develop increased capabilities. In Europe, EUMETSAT and ESA have a combined budget of $449 million. While the funding level is expected to grow in the US, it is expected to fall in Europe to the $100 million mark with completion of the programmes (Euroconsult, 2005a).

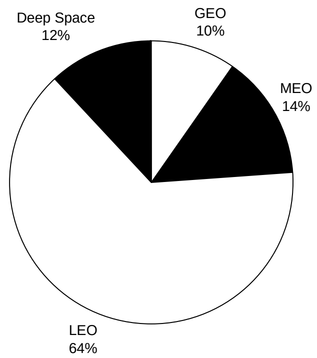
Science budgets tend to be quite stable over time because of constant needs, and scientific programmes require long-term funding for implementation. Therefore, science budgets are not expected to significantly fluctuate in the medium term.

However, space exploration initiatives are a key issue in the long term, as programme implementation will require significant funding starting in the next decade.

Orbits

Figure A3.5 illustrates the predicted division of satellites by orbit worldwide, over the period 2004-2013. Similar data are not available at the European level. However, it is of note that MEO predictions are influenced by the Galileo programme. The MEO/HEO government market should generate launch contracts with a total estimated value of $2.3 billion, where these are fully captive of domestic launch vehicles (Euroconsult, 2004).

Figure A3.5: Institutional Civil Satellites to be Launched Worldwide by Orbit 2004-2013
(source: Euroconsult, 2005a)



The civil LEO satellite market is also growing fast, with 77% of the 225 LEO satellites to be launched will be operated by civil agencies for various purposes (Euroconsult, 2004). The number of civil LEO satellites has increased globally by 52% compared to the past decade. This strong increase reflects the concern shown by civil agencies regarding the cost and lead time of their satellite projects, which encourages them to fund cheaper and smaller but more numerous and more rapidly advancing spacecraft. It also reflects the growing number of countries that are investing in space research and technology for operational objectives such as national resources management, weather forecast, disaster prevention and also for the development of their industrial capabilities. Technology for small LEO satellites is more immediately accessible to newcomers than other orbits, and it also reflects the importance of LEO for Earth observation (Euroconsult, 2004).

Level of Cooperation

Faced with budget constraints, major space agencies have taken significant measures to maximise the results of their satellite development programmes for scientific, technological and remote sensing missions in LEO. These include:

- the standardisation of satellite platforms – European domestic space agencies have started to order multiple satellites using the same platform provided by a single manufacturer;
- cooperation among domestic agencies within Europe for the use of common platforms;
- bi-lateral cooperation between space agencies to jointly develop a mission with no exchange of funds, based on in-kind contributions; and
- dual use of space systems with civilian and military agencies sharing the benefits of a mission, even if they have contributed differently to its funding.

A3.3.2 The OECD Scenarios

In relation to the civil institutional market, the OECD scenarios suggest the following:

- ***Scenario 1: Smooth sailing*** - In this scenario, all of the world's major space-faring countries co-operate actively on the development of all aspects of civil space, including space exploration and science, basic R&D for the development of space technology as well as on the expansion of space infrastructure. The positive political and economic climate provides a good basis for strengthening international co-operation to deal with the world's principal social problems, such as telemedicine, distance learning through tele-educations services, precision farming, tracking of GHG emissions, etc.

- ***Scenario 2: Back to the future*** - International rivalries results in a large share of civil space budgets devoted to projects likely to create "soft power" in the form of additional prestige or as a way to strengthen or extend international influence. For example, countries step up their respective exploration programmes for reasons of prestige. In this period of high social demand, the range of space applications increases and new dual-use technologies are developed. Significant advances in artificial intelligence, robotics and nanotechnology contribute to cut the cost of space missions.

- ***Scenario 3: Stormy weather*** - Depressed economic conditions put strong pressures on discretionary budgets. No major common international exploration programmes are pursued, as national and regional programmes remain in the forefront. Space agencies undertake strategic co-operative efforts, essentially to take advantage of and to influence the research efforts of other nations. Even though civil budgets are quite limited, some countries still recognise that civil space programmes can be an investment and national civil space research efforts are largely devoted to the development of dual-use technology. This applies notably to meteorology, Earth observation, telecommunications and navigation systems as well as to launchers.

A3.3.3 Scenario Development

Key Variables

There are two driving variables which are likely to affect the civil space market. These are:

- general economic conditions and thus available national/international budgets; and
- international relations and cooperation.

European civil institutional budgets are influenced by general economic conditions and are growing at a rate of around 2% per annum. Current opinion suggests that the worst-case scenario is that the civil market may stagnate. In other words, there is no realistic scenario under which the market is expected to decline. On this basis, three scenarios are suggested for the civil market:

- no growth, budget based on a five-year rolling average;
- annual growth of 2% to reflect current levels; and
- annual growth of 7% (extending ESA's aims set out in Agenda 2007).

Similarly, four degrees of cooperation can be identified:

- international cooperation amongst Europe, the US, Russia, China and other space-faring countries;
- Europe-US cooperation;
- cooperation within Europe;
- no cooperation, some European countries have national space programmes.

Other Variables

There are a number of other factors which may vary under each of these scenarios, including:

- priority given to different applications, and therefore orbits;
- extent of commercial procurement vs. protectionism; and
- technological developments and associated costs.

These are likely to be influenced by developments in other markets and will be considered in more detail once agreement has been reached on the key characteristics of the demand scenarios to be taken forward.

A3.4 The Future European Defence Institutional Market

A3.4.1 Business-as-Usual Forecast

Overall Market Size

As stated in Section 2, the total value of the global military space market was nearly $20 billion in 2004 and, in recent years, it has grown at a rate of over 7% per year. However, this is dominated by US spending, and the collective European budget of six countries is much less. Military space budgets in Europe have declined over time, from roughly €900 million in the mid-1990s to €590 million in 2002, however they increased in 2003 in relation to the start of payments for the UK's Skynet-5 programme (Euroconsult, 2005a).

Euroconsult (2005a) suggest that global military markets will grow at higher rates than the civil market, due to the continuous expansion of the US military space programme and increased funding efforts from European countries to finance their domestic programmes. Whilst an optimistic global growth of 4% to 6% is suggested, only a soft increase in military expenses in Europe can be expected.

The number of satellites to be launched over the decade for institutional military customers, under a business-as-usual scenario predicted by Euroconsult (2004), has been established on the basis of the satellite programmes currently planned by government agencies, assuming the continuation of some programmes through follow-on satellites and the launch of new satellites by governments who are already operating satellites.

Figure A3.6 (overleaf) indicates the predicted launch market value, number and mass of Western European military satellites predicted by Euroconsult over the period 2004-2013. These data do not provide an obvious trend from which to extrapolate predictions for a further three years (in line with 2007-2016 timeframe being considered here).

The total number of military satellites predicted for launch during the period 2004-2013 is estimated at 21-28 in Western Europe, out of a total of 190-294 globally. This equates to 2-3 satellites per year. The predicted launch market value ranges from €503-€668 million, and the total mass is 44-68 tonnes. These are based on assumptions set out in Tables A3.9 and A3.10.

Table A3.9: Assumptions on Satellite Launch Mass

Application	1990-2003 (observed)	2004-2008 (planned)	2009-2013 (planned)
Meteorology LEO	1,270 kg	1,950 kg	3,000 kg
Meteorology GEO	1,520 kg	2,100 kg	2,100 kg
Earth observation LEO	1,400 kg	1,300 kg	1,500 kg
Telecom non-GEO	800 kg	600 kg	600 kg

Source: Euroconsult (2004)

Figure A3.6: Predicted Western European Defence Institutional Space Market for 2004-2013
(source: Euroconsult, 2004)

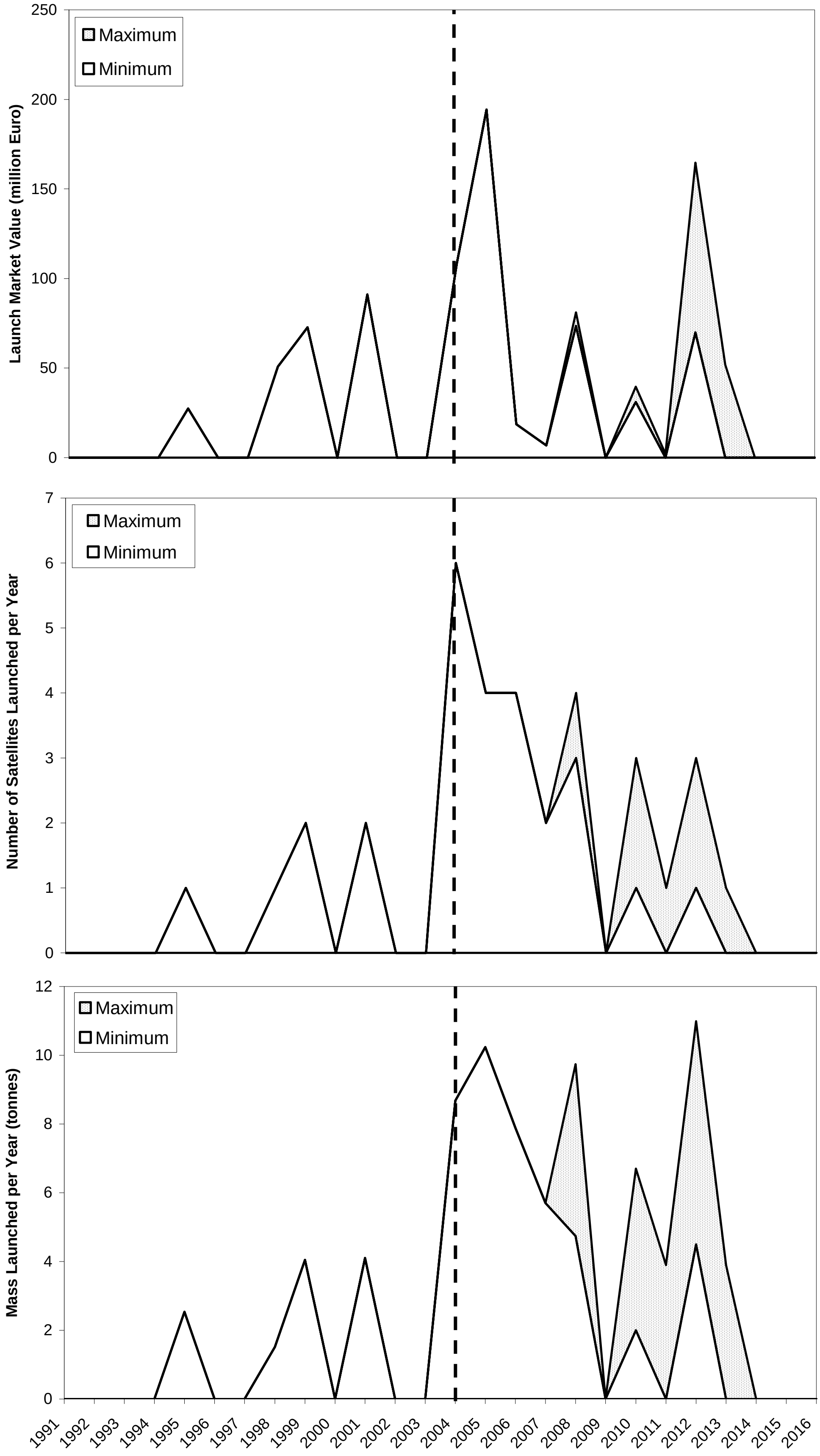


Table A3.10: Assumptions on Specific Launch Prices		
GEO/HEO	**MEO**	**LEO**
A function (exponential regression) has been established for historical and future commercial satellites. This has adapted for institutions as it is assumed that launch prices will not decrease as much for institutions as for commercial customers.	Average constant price of $18,000/kg	Average constant price of $8,000/kg for launch mass less than 2,000 kg Average constant price of $18,000/kg for launch mass greater than 2,000 kg
Source: Euroconsult (2004)		

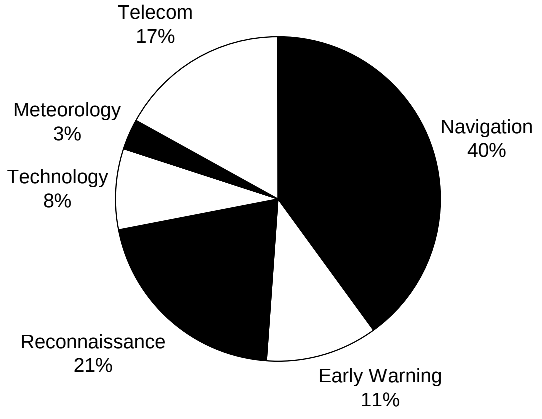
The budget deficits faced by most military institutions are encouraging them to optimise their spending for satellite networks through purchase of commercial off-the-shelf (COTS) satellite hardware, lease of capacity or systems from commercial operators and service contract with private companies under PFI. The success of PPP and PFI should be a key factor for the development of civil and military programmes in these regions, meaning strong involvement of private partners and new types of relationships between governments and industry (Euroconsult, 2005a).

Military operators find commercial systems an increasingly attractive solution because of their fast growing technical capabilities and because future defence budgets are largely static even as defence communications are escalating strongly.

Applications

Figure A3.7 illustrates the proportion of military satellites by application to be launched worldwide between 2005 and 2010. At a global level, the highest levels of demand are expected to be for navigation and reconnaissance satellites. In particular, GMES will deliver Earth observation data for civil and military-related uses, such as treaty verification and crisis monitoring.

Figure A3.7: Military Satellites to be Launched during 2005-2010 by Application, Excluding Classified Programmes *(source: Euroconsult, 2005a)*

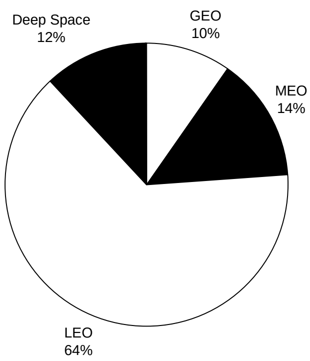


Orbits

Military GEO satellites are expected to be the key growth market, and are likely to become more dominant in European and other non-US markets as military agencies procure dedicated satellites for communication services (Euroconsult, 2004).

The number of LEO satellites for military operators could remain stable at about 50 units to be launched by a limited number of governments (US, China, Japan, France, Israel, Germany). However, depending upon certain restrictions being removed on technology transfers (as is the case of Earth observation) a higher number of satellites could be required by a larger number of military agencies (Euroconsult, 2004).
Figure A3.8 illustrates the predicted division of satellites by orbit worldwide, over the period 2004-2013. Similar data are not available at the European level.

Figure A3.8: Institutional Military Satellites to be Launched Worldwide by Orbit 2004-2013 (Maximum Scenario) *(source: Euroconsult, 2005a)*



Levels of Cooperation

To dater, cooperation exists in the form of the exchange/lease of capacity or interoperability of national systems. For example:

- in the field of observation, Italy and Germany have agreed to develop interoperable ground stations. German and French military officials will have reciprocal access to each other's satellites and France signed a similar agreement with Italy; and

- in the field of communications, France, Italy and the UK successfully bid to jointly provide communications capacities to NATO (North Atlantic Treaty Organisation) from their respective domestic systems.

Further integration will depend on the progress made by the Common Foreign Security and Defence Policy but, in any case, no shared system can be considered before 2015, when the national systems will need replacement.

A3.4.2 The OECD Scenarios

In relation to the institutional military market, the OECD scenarios suggest the following:

- ***Scenario 1: Smooth sailing*** - a more peaceful world, with less priority on military expenditures in general, and therefore military space budgets decline overall. However, space-faring countries outside the United States devote relatively more resources to military space as they strengthen their network centric warfare capability. Particular attention is devoted to developing a military space infrastructure in the areas of telecommunications, Earth observation (EO) and navigation for carrying out intelligence, communications, command and control functions. There is increased co-operation between major powers;

- ***Scenario 2: Back to the future*** - growing tensions between the EU/US and another space-faring country leads to a new type of space race and the gradual 'weaponisation' of space. EU countries strengthen their common security and defence policy. Military space plays a central role and a core group of like-minded countries agree to coordinate their military space programmes so as to minimise duplication. This leads to the rationalisation and development of Europe's military space infrastructure. Europe establishes an independent space capability, but also requires interoperability with US military space-based assets. The military space industry of the US and the EU becomes increasingly integrated. The demand for communication and EO satellites increases; and

- ***Scenario 3: Stormy weather*** - the world is perceived as increasingly hostile and military space budgets increase worldwide. It should be noted that competition from terrestrial military systems (e.g. drones) does not stop the development of space military systems. A growing number of countries decide to develop or strengthen their own military space assets, including for communication, Earth observation and navigation. Europe launches a major military space programme by the end of 2010s. The programme is designed to reduce the large and growing gap in military space capability with the US and to keep up with the efforts of other major space powers. Europe develops this military system for space activities to ensure its independence and its autonomous and informed decision-making.

A3.4.3 Scenario Development

Key Variables

There are three driving variables which are likely to affect the military space market. These are:

- the degree of military action worldwide;
- international relations and cooperation; and
- general economic conditions and thus available national/international budgets.

Whilst these factors are all interrelated, it can broadly be assumed that the degree (and location) of military action affects both the potential for international cooperation and the available budget (which may at the expense of other budgets). Conversely, where the level of military action is low, restrictions on military budgets may influence the degree of cooperation achieved.

Therefore, each of these variables has a range of possible scenarios. The range of military action can be summarised by the three OECD scenarios:

- a peaceful world;
- some military action, possibly bloc rivalries; or
- a hostile world of political mistrust and autonomous powers.

Similarly, four degrees of cooperation can be identified:

- international cooperation amongst Europe, the US, Russia, China and other space-faring countries;
- Europe-US cooperation;
- cooperation within Europe;
- no cooperation, some European countries have domestic military space programmes.

Three scenarios can be suggested for European defence institutional budgets:

- a reducing budget - the general trend in European defence space budgets is shown in Figure 2.5 and, by extrapolating this trend, it is suggested that the overall budget will decline by 1%-2% per year. Euroconsult (2005a) notes that European budgets are likely to be limited, with no significant positive perspectives in the medium term. However, under a peaceful world scenario, it is possible that reductions could be greater, perhaps 5%;

- a stable budget – a relatively stable budget is maintained, this may be similar to the current situation, which has a small annual decline; and

- an increasing budget - Euroconsult (2005a) suggests a global rate of growth in defence space budgets of between 4% and 6% in an optimistic scenario. This could be due to both a continued expansion of the US military space programme as well as funding increases from European countries to finance their domestic satellite systems development and procurement. This could be in the context of either generally increasing military budgets or a reflection of the growing importance of space relative to other military platforms. This is supported by ASD-Eurospace (2006) which notes that there are significant expectations on the development of defence markets for European space systems, as there is expected to be a growing demand for space applications for security and defence. Therefore, a rate of 5% growth could be taken as an optimistic, but realistic scenario for Europe.

Other Variables

There are a number of other factors which may vary under each of these scenarios, including:

- priority given to different applications, and therefore orbits;
- extent of commercial procurement vs. protectionism; and
- technological developments and associated costs.

These are likely to be influenced by developments in other markets and will be considered in more detail once agreement has been reached on the key characteristics of the demand scenarios to be taken forward.

A3.5 The Use of Constellation of Satellites vs Big Platforms

The vast majority of communications satellites rely on the geostationary orbit (i.e. big platforms); however, some operators have installed satellite systems using non-geostationary orbits (constellations). The choice of orbital configuration has to take into account not only the quality of the service to be delivered, but also the feasibility and technical risk associated with the manufacturing, the operation, and the maintenance of the constellation. Table A3.11 (overleaf) summarises the advantages and disadvantages of the different orbits.

Whilst non-GEO constellations may optimise service distribution, there are also technico-economic challenges specific to non-GEO systems. Relative to GEO satellite systems, LEO systems, and to a lesser extent MEO systems, have specific technical features (shorter lifetime, capacity lost over oceans, complex terminals, etc) that make their technical design challenging, increase maintenance costs and can reduce profit margins. Considering their high upfront investment costs, and the necessity to recoup that investment as fast as possible, but only once the whole constellation has been launched, the issues of service distribution, pricing, and marketing are highly sensitive in the business plans of such systems.

Constellation-based satellite systems can be used in the following applications:

- **Voice communication**: constellations can be set to enable people to communicate by phone anywhere in the world using satellite phones. Unlike GSM, coverage is provided by satellites, not transmitters and base stations on the ground. By orbiting in the atmosphere, the signal is not limited by masts and towers, which are not economical to establish in many terrains and environments around the world such as at sea or in a jungle. Such system can also deliver paging, modem and fax services. Examples include Globalstar, ICO and Iridium.

Table A3.11: Advantages and Disadvantages of the GEO/MEO/LEO Satellite System Options

	Pros	**Cons**
GEO	• A single satellite can serve a large continental region and only three satellites are required for global connectivity • Both global and local service capability available for a relatively economical investment cost • No tracking capability is required for customer ground equipment • Cheaper • Better reliability	• Large and heavy satellites loaded with a significant mass of station-keeping fuel • Sensitive to solar storm • Larger ground equipment and higher satellite power than MEO/LEO systems • Highest signal propagation delay (240ms round-trip) • Attractive orbital slots in limited supply • Consequences of failure are significant
MEO	• A compromise between GEO and LEO systems, requiring more spacecraft than GEO but far fewer than LEO for global service • A round-trip propagation delay of the order of 70ms • Risk of failure mitigated	• Exposure to high-energy charged particles in the Earth's Van Allen radiation belt • Capacity availability limited when spacecraft are flying over the ocean and uninhabited land areas • Tracking antennas required • Significant upfront investment required
LEO	• Low altitude translates into less signal delay, lower power requirements and smaller ground terminals than higher altitude systems • A round-trip propagation of the order of 6 ms • Risk of failure mitigated	• Exposure to high-energy charged particles in the Earth's Van Allen radiation belt • Complex ground control, tracking antennas required • Shorter lifetime • The lower the altitude, the more spacecraft are required for service • Solar activity increases atmospheric drag • Capacity availability limited when spacecraft are flying over the ocean and uninhabited land areas • Significant upfront investment required

Source: based on Euroconsult (2004) and pers.comm.

- **Internet communication**: the internet, and specifically broadband communications, require a large amount of information to be transmitted rapidly to anywhere in the world for military and commercial use. LEO constellations are often used due to their proximity to earth they can transfer data much more quickly than geostationary satellites, although geostationary servers are still used, for example, to provide coverage to a large geographical and popularised areas. Constellations include Teledesic, Skybridge and Spaceway.

- **Navigation**: a constellation of three or more satellites is necessary in navigation in order to pinpoint a position anywhere in the world by measuring the distance between each satellite and a specific location. Coverage must therefore be extensive and accurate requiring coordination of many satellites and ground stations. The US Global Positioning System (GPS), Russian Glonass the Galileo programmes are examples of this use.

- **Remote sensing**: is a growing area for small satellites to constantly monitor scientific phenomenon such sea levels, disaster zones and meteorological movements. Systems include the Disaster Monitoring Constellation (DMC) and RapidEye.

- **Satellite Radio**: Sirus and XM Radio in the US are examples of the use of satellite constellations to provide radio services across US states, negating the need for large numbers of transmitters.

In the past, the preferred construction of a satellite constellation has involved LEO satellites because the benefits of a constellation are maximised when adopting LEOs. However, progress has been slow as a constellation with 50+ satellites can be expensive when uncertainty surrounds future demand. Consequently, early LEO constellations found it difficult to make a profit, with operators such as Iridium, Globalstar and Orbcomm going bankrupt in the late 1990s. Although these companies are now operating the LEO constellations under revised business models, it is of note that Iridium has applied to substitute a single geostationary satellite for the replacement of its 96 non-geostationary satellite system. Whilst this does not suggest that the substitution will definitely occur, the option is available to the company.

More recently, there has been suggestion in the US that singular, large meteorological GEO satellites may be replaced by a number of small GEO satellites; effectively moving from a big platform to a constellation of small GEO satellites. Whilst this is still only a suggestion, it is possible that similar approaches may be explored for large European GEO satellites in the future.

The key issues are, therefore, the potential for:

- constellations of many LEO satellites to be used in favour of a small number of GEO satellites, and *vice versa*; and
- a number of small GEO satellites to replace singular large GEO satellites.

The implications of these issues for the space industry relate not only to the overall value as illustrated by data in Section 2, but rather to the level of activity, i.e. the capacity of the industry to manufacture and launch constellations forms a spike in activity which may not be sustained over the long-term. In addition, the benefit of small platforms may be in demonstrating new payload technologies and exploiting new markets and business models.

At present, there is no particular trend in any direction, although GEO satellites are a well developed market and have traditionally been used for telecommunication systems. Thus, technological development can facilitate and affect the relative advantages and disadvantages of the different approaches. Furthermore, small and large platforms can be complementary and/or allow different (competing) business models. For example, large-scale commercial services can operate using a large platform at minimum costs and maximum capacity, whilst small platforms can allow capacity to increase in line with market growth. Therefore, the potential for using constellations vs. big platforms is likely to depend on the market demand as well as the degree of technological development under future scenarios.