Executive Summary

Space technologies have become an important part of everyday life. Weather forecasting, air traffic control, global communications and broadcasting – these and many other essential activities would be almost unthinkable today without satellite technology.

A new international landscape for space activities…

The landscape for space activities is starting to change radically. It now includes a wide diversity of institutional and private actors. There have never been so many countries with satellites in orbit (more than 50 countries). The emergence of Brazil, India and China as established space powers alongside the Russian Federation (*i.e.* the BRIC countries), but also as a new nexus of space technology transfers towards developing economies, is a key characteristic of the new landscape. The Russian Federation has for instance launched more rockets than any other country every year since 2006. Asian countries led by China (15 launches in 2010, like the United States) are also gradually outdistancing Europe in terms of the number of launches and satellites sent in orbit.

The total space budget of the 35 countries examined in this report represents conservatively USD 64.4 billion in 2009, and an estimated USD 65.3 billion in 2010, with the bulk of funding in G7 and BRIC countries. All G20 countries have space programmes. Five countries have invested more than USD 2 billion in both 2009 and 2010 (the United States, China, Japan, France and the Russian Federation), with the United States leading the way at more than USD 43 billion. As countries have diverse strategies in developing space programmes (*i.e.* focusing on manufacturing or selected downstream activities), special spotlight sections have been drafted in this report on current members of the OECD Forum on Space Economics (the United States, France, Italy, Canada, the United Kingdom, Norway), as well as on India, China and Brazil.

Almost 1 000 operational satellites are now in orbit with diverse earth observation, telecommunications, navigation and positioning missions. In parallel to the growing importance of these down-to-earth applications, science and space exploration remain key missions of space agencies, invigorating international scientific co-operation. In early 2011, seven probes are flying through the solar system, three satellites are orbiting Mars, two active rovers are on Mars' surface, and two satellites are orbiting Venus. In the 2009-10 period, China, India, Japan, Europe and the United States each launched a spacecraft to orbit the Moon. China has already launched several taikonauts in earth's orbit, while the International Space Station has been inhabited and visited by astronauts and cosmonauts since 2003.

… the space economy as an engine of economy growth…

In comparison to other sectors, the space sector has fared relatively well since 2008 despite the economic crisis, thanks to its specificities as a key strategic sector (*i.e.* national imperatives and institutional research and development funding), but also because of the vibrant "space economy". This space economy includes many commercial activities that have been derived over the years from the space sector's research and development (R&D) missions. Several mature downstream activities have reached mass markets, and include information technology products and services, such as satellite television and GPS receivers. Even tourism-related packages are starting to be commercialised (*e.g.* space-related amusement parks, suborbital flights):

- Mapping the space economy remains a complex process. Estimates vary widely, and many involve some degree of double counting. But the most reliable estimates suggest that the revenues derived from the wide diversity of space-related products and services amounted to some USD 150-165 billion in 2009.
- Telecommunications still represent the main commercial space market, and several satellite operators have broken records in revenues since 2008 despite the economic crisis. They have benefited from growing mass markets (satellite television broadcasting) and a robust demand from institutional users (defence, new customers in the developing world, development of anchor contracts). The lease of transponders and communications via satellite represented some USD 11-15 billion in revenues, while satellite broadcasting (*e.g.* television via satellite) some USD 65-72 billion in 2009.
- The geopositioning market, a growing new segment building on satellite capacities (with products such as the now common car-navigation), represents USD 15 billion in revenue in 2009. With the advances in smartphones and other mobile products, all offering geopositioning capabilities, more growth is expected.
- Other sectors include the satellite earth observation sector, a market valued in 2009 at some USD 900 million to USD 1.2 billion, and the space insurance industry, which generates around USD 750-800 million a year.
- The overall growth of space applications has impacted the rest of the value chain, particularly the main satellite manufacturers. The commercial and institutional demand for satellites remains relatively strong and geographically diversified, particularly for military/dual-use satellites. The total five-year value of satellite production is estimated at some USD 65.5 billion.

This overall encouraging environment for the space sector, in the midst of a serious economic crisis, may not last indefinitely. On the commercial front, despite the growth of space applications and the financial success of satellite telecommunications, the main operators will reach the end of a cycle over the next three years, having placed all the contracts for replenishing their respective fleets of satellites. But more importantly, the space sector manufacturers are still dependent worldwide on institutional budgets for much of the R&D and on governmental customers for satellites and launchers. The potential restrictions in budgets in many countries, in science and defence particularly, may affect the industry over the next three years, as budget cuts filter down the entire value chain.

… more innovation for future economic growth…

The space sector has often been considered one of the main frontrunners of technological development, since the beginning of the space age. The number of space-related patents has almost quadrupled in fifteen years. The countries' share in space-related patents over the 2000-08 period shows the United States and Europe leading, followed by Korea and Japan. However, in terms of revealed technological advantage, several countries demonstrate a level of specialisation in space technologies patenting, particularly the Russian Federation, France, Israel and the United States.

Over the next five years, many advances are expected in the classical sphere of space applications (telecommunications and navigation applications), where satellites could contribute further to the development of commercial information systems and networks (*e.g.* more broadband to rural areas, high definition and 3D television via satellite, air traffic management). But in addition, several relatively new space systems could be moving from demonstrations to potentially routine systems. They include automatic identification systems (AIS) via satellite which allow countries to monitor ship traffic along their coasts, and space situational awareness, which serves to track the trajectories of operational satellites and large space debris in orbit.

… space activities and returns on investments…

The investments in space programmes are often justified by the scientific, technological, industrial and security capabilities they bring. But these investments can also provide interesting socio-economic returns such as increased industrial activity, and bring cost efficiencies and productivity gains to other fields (*e.g.* weather forecasting, telemedicine, environmental monitoring and agriculture previsions):

- In a majority of countries, space programmes are contracted out to national industry. Although economic impacts may vary depending on the country and the level of its specialisation (*e.g.* applications *versus* manufacturing), records on positive industrial returns from institutional investments are growing. Norway, which has a small but active space programme, has detected a positive multiplier effect since the 1990s, *i.e.* for each million Norwegian kroner of governmental support through the European Space Agency (ESA) or national support programmes, the Norwegian space sector companies have on the average attained an additional turnover, usually as new exports or new activities outside the space sector. In 2009, NOK 1 million invested provided a return of some 4.7 million. In Denmark too, each EUR million of Danish contributions to the European Space Agency (ESA) has generated a turnover of EUR 3.7 million in average. In Belgium, the same type of multiplier has been detected, for each EUR million of governmental support through ESA, EUR 1.4 million have been generated by the Belgian industry. In the United Kingdom, the space industry's value-added multiplier has been estimated to be 1.91. Finally, the most recent Federal Aviation Administration (FAA) study on the economic impacts of the US commercial space activities has also shown a rather stable multiplier ratio since 2002. In 2009, for every dollar spent commercial space transportation industry, USD 4.9 resulted in indirect and induced economic impact.
- Earth observation data and geopositioning products are benefitting to an increasingly large number of sectors, via cost efficiencies and productivity gains. Weather prediction, which relies particularly on meteorological satellites coverage, has become a routine service for citizens, companies and governments alike. In economic terms, a recent study

in the United States has estimated that the benefit of the investment in public weather forecasts and warnings represents annually about USD 31.5 billion, compared to the USD 5.1 billion cost of generating the information. Adequate irrigation is also essential to improve food productivity in many regions, especially as water is becoming scarcer. In India, under the "Rajiv Gandhi National Drinking Water Mission" of the Ministry of Rural Development, Indian satellite remote sensing technology is already used for preparing groundwater maps in ten states. Since the success rate of bore wells reached already around 90% in these states, the project was extended to cover the entire country.

… preserving a skilled workforce in the space sector…

The space economy with all its various downstream products and services contributes to employ hundreds of thousands of employees in diverse OECD and non-OECD countries, although data are not known for all countries. Focussing on the narrower space manufacturing sector, some 170 000 people work in the space industry in the United States, some 31 000 people in Europe and 50 000 in China. The space sector is generally a very concentrated industry, as for example, four large industrial holdings are directly responsible for more than 70% of total European space industry employment. The dominant job categories comprise engineers and technicians involved in designing, manufacturing and operating space and ground segments, but also information technology specialists.

As in other parts of the economy, the space sector is particularly affected by the large wave of retirement of the baby boom generation. Many of the engineers and scientists who have developed space systems over the past three decades are retiring, and this situation comes in a context of a sharp decrease in the engineering and scientific population under 30 years old in most OECD countries. Although space remains *a priori* a very attractive field for young students, the space sector increasingly competes with other sectors for the scientifically minded students (*e.g.* game software development, biotechnologies). Taking into account the increased globalisation of the space industry and emergence of many talents in new space-faring countries, the international mobility of human resources in science and technology could become a key feature in the space industry employment strategies, although national security restrictions would still often apply (*i.e.* civilian-military nature of many space systems).

… outlook for the space economy…

Societal challenges – such as the environment, the use of natural resources, the increasing mobility of people and goods, growing security threats, and the move towards the information society – are intensifying in both OECD and non-OECD countries. In parallel, a number of countries are rapidly emerging as new actors in the world's economy.

Some countries may see their institutional space budgets suffer from potential negative effects, caused by near-term economic conditions. But overall the globalisation of space activities, as well as the practical contributions of space applications to meet key societal challenges, are so significant that the space sector and the wider space economy could probably continue expanding for the foreseeable future.