

Solutions in Space

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Introduction

Space, and man's relationship to it, has captured the human imagination for centuries. During the 20th century, dreams of space exploration became reality, and now dozens of countries, in particular in the OECD area, devote major resources to space programmes. But is this money well spent? Can we use space to find solutions to Earth's problems not available on the ground, or are we just pursuing high-priced star-filled dreams? Space technology may have brought us benefits from satellite telecommunications and their associated benefits such as telemedicine, but could we be doing more to exploit the link between space exploration and Earth application?

Space applications have unique characteristics, such as a global vision of the world and the ability to spread information over broad areas, which could be used to make a major contribution to meeting several enduring challenges of the 21st century such as changes to the environment, use and management of natural resources, the impact of increasing international mobility, and the move to the knowledge society.

OECD studies suggest that there will be high demand for space applications in the future and that space applications have substantial potential to help tackle these problems.

But if that potential is to be realised, a number of important conditions must be met: space systems require further development, need to be better integrated with ground-based systems, and be provided in a sustainable and predictable manner. And for that to happen, policy makers will need to act on the technological, legal, economic, regulatory and institutional front.

This *Policy Brief* draws on OECD studies by the International Futures Programme (IFP) on how to ensure that the space sector contributes fully to the development of the economy and society. It highlights some of the issues at stake concerning the role of space assets for tackling long term societal challenges, and what actions governments could take to use space infrastructure more efficiently. ■

How can space help tackle major social challenges?

Space-based applications are particularly attractive to decision-makers for three main reasons: they offer the ability to communicate anywhere in the world whatever the state of the ground-based network; they can be used to observe any spot on Earth accurately; and they can be used to locate a fixed or moving object anywhere on the surface of the globe.

Because of these characteristics, space can make a useful contribution in both OECD and non-OECD countries in five key areas: the environment, the use of natural resources, the increasing mobility of individuals and products and its consequences, the growing threats to civil security and the shift towards the information society.

- In terms of the *environment*, space technology could be used to gather data that could be used to monitor specific regional situations over time, enabling scientists to forecast possible degradation of the environment and to plan for remedial action, or to mitigate the effects of harsh climate changes.
- Space technologies can also contribute to more efficient use of *natural resources* worldwide, such as the management of water resources, or monitoring the changing state of forests – deforestation, fire damage – to help manage this resource more effectively.
- Though *mobility of people* is essential to modern civilisation and economies, the continuing and growing global demand for mobility cannot be met simply by expanding today's means of transport. Space-based solutions, using Global Navigation Satellite Systems (GNSS) and satellite communications, may increasingly help meet the mobility challenges by allowing better traffic management and monitoring, while facilitating the mobilisation of emergency services.
- Space can also contribute in helping governments meet *growing civil security threats*, whether from terrorism, economic crises, health emergencies, or rapid population growth and massive migration to the cities in some countries. In the case of disaster management, the convergence of several space technologies – telecommunications, satellite positioning and Earth observation – have recently shown in the aftermath of the tsunami in Asia how space could help by providing key data to create basic maps of the new seabed and coastline.
- The creation and diffusion of information and knowledge are of strategic importance for economic development in both OECD and non-OECD countries. Space-related activities contribute to developing an *information society* because of the amount of research and development involved in developing space technology, and because of the number of scientific missions that new space systems allow. Communication satellites are also having a marked impact on the ability to connect the world, especially when populations are in remote areas where no land-based communications networks are available. ■

Are space solutions cost-effective?

If there is no doubt that space technologies can help meet a growing number of major social and economic challenges, there is also the question of whether equally effective land-based solutions could be found at lower cost. This question is difficult to answer, partly because credible cost/benefit analyses for future applications are not easy to make in the best of circumstances and this is even more so in the case of space.

The costs of space systems are hard to estimate, notably because precise development costs are often not taken into account or are unknown. Do you include the development costs of the rocket used to launch a satellite when calculating its cost, and if so how much of them? And how do you calculate the development costs of the rocket itself? The result is that in the case of multi-purpose satellite systems, for example, it is almost impossible to allocate costs meaningfully among different applications.

On the benefit side, it is very difficult to trace the overall societal benefits of space systems, such as lives saved or property spared thanks to the timely availability of space data in cases of disaster, or how much of an area's social and economic development can be attributed to the fact that satellite communications were made available in an area previously cut off from land-based systems. Space assets may play an essential role, but often represent only a small component of the entire socio-economic value chain of a product or a service.

Another difficulty from a decision-making perspective is the fact that technological advances can affect both costs and benefits, so that cost/benefit studies quickly become out of date. For example, there have been rapid advances in satellite communications and Earth observation technologies in recent years. This means that more can be done for less cost with the most recent generation of Earth observation satellites and that future generations will be even more effective.

Even when credible, positive cost/benefit ratios are obtained, one may still wonder whether other uses of the resources would have produced higher payoffs. However, it is not always easy to compare space and terrestrial solutions, and it may be impossible when space offers a unique capability that cannot be duplicated by other means.

Paradoxically, the benefits of space assets may sometimes become clearest when they fail to function properly, forcing users to find alternatives. For example, the Landsat 7 satellite data has been used extensively by US forestry officials to identify burned areas over the years. When one key instrument failed in 2003, the officials were forced to fall back on other less adequate sources.

Cost/benefit studies conducted so far – although partial – tend to confirm the positive overall view of the potential contribution that space might make to society. OECD expertise and methodologies could potentially help further in that domain. ■

Do space activities have a promising future?

As seen above, space technologies have inherent and unique strengths that are of great use to policy makers and to private companies. But the space sector is an economic sector like no other with unique characteristics.

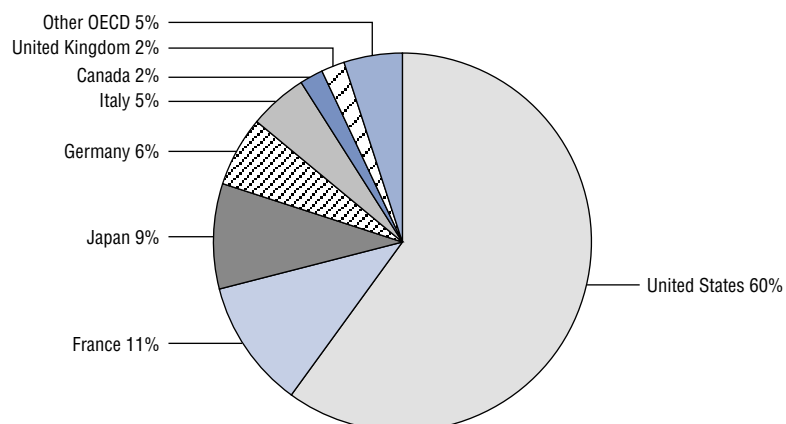
Although there have never been so many countries involved in space-related activities, putting a spacecraft into space and operating it remains complex and costly, due to the extreme conditions of the space environment. Major progress has been achieved over the last decades, including notably the successful development of several families of launchers (e.g. Soyuz, Ariane, Atlas), satellites and orbital platforms, but nonetheless the space business remains a risky and expensive undertaking. If a launch rocket fails, not only the rocket is lost but also its highly expensive payload.

OECD governments devote the largest budgets for civil space R&D programmes, in particular the United States (see Figure 1). The worldwide public civil space budget rose to more than USD 24 billion in 2003, USD 15 billion of which went to the National Aeronautics and Space Administration (NASA). However, the level of institutional funding does not always correspond to the richness of the space programmes and the growth of an indigenous space industry, as illustrated by India's achievements with a fraction of what other governments spend (USD 600-700 million annually). As in any economic sector, the purchasing power parity and local labour costs need to be taken into account.

On the commercial side, the international space industry is highly concentrated and national markets are often protected for strategic reasons. This has diverse consequences on innovation, as incentives to innovate may be weaker than in a more open market environment. What is more, commercial space enterprises face strong cyclical downturns, like the aeronautical and defence sectors, and despite the high risks the sector suffers from chronic overcapacity. The space launch and satellite manufacturing capacities currently available worldwide far exceed demand from government and commercial markets.

Nonetheless, OECD analysis provides rather encouraging prospects for the future of space activities worldwide. This remains true for three very different

Figure 1:
OECD BUDGET FOR SPACE R&D BY COUNTRY, 1999
 Percentage of total OECD government appropriations or outlay on R&D (GBAORD) to civil space programmes



Source: OECD (*Space 2030: Exploring the Future of Space Applications*, ISBN: 92-64-02032-2).

views of the future: “smooth sailing:”, a global world order under the benevolent guidance of international organisations in which free markets and democracy gradually become the accepted universal model for national institutions; “back to the future” where three major economic powers (US, Europe and China) dominate the world; and “stormy weather” where strong disagreements among major powers lead to a gradual erosion of international institutions.

Space applications would be pursued in all three scenarios, although simulations suggest that the efficiency of the overall space infrastructure suffers when there is less international co-operation. The increasing development of military space systems may also have strong consequences on the shape of future systems.

In general, information-intensive applications such as satellite-based telecommunications, Earth observation and navigation could have a bright future in many countries, if governments enact policies and regulations to provide the necessary framework conditions. But the prospects for more complex applications such as public space transport, space tourism, or space-based manufacturing are more uncertain, given the cost of access to space, which is unlikely to decline drastically over the next decades, and the complex technical problems of working in space.

What does emerge from the three scenarios is that there would appear to be some scope for innovation in international and regional co-operation on economic, legal and institutional aspects of space activities. This could help to boost economies of scale, optimise use of resources and provide more viable space infrastructure. The OECD could prove a useful venue for space-sector stakeholders in this regard. ■

Why are framework conditions so important?

Space is different from other sectors of the economy because of its strong strategic and security ramifications, as well as its high technological costs. Nonetheless, OECD research suggests that when it comes to civilian and commercial space applications, whether publicly or privately funded, an adequate regulatory and institutional framework is as important for efficiency in space as it is on Earth.

But at the moment, the political, legal, regulatory and financial framework for using space leaves much to be desired. Who owns space? Who decides who can use it, and for what purpose? These are just some of the major unanswered questions that make it difficult for individual companies or governments to plan space activities.

There are a number of uncertainties on the institutional front in many space-faring countries concerning “**who does what**” in space. In fact there are questions on how the different public and private space actors are positioned and how to make their relationships work more efficiently.

A second set of issues relates to the **rules of the game** – the legal and regulatory framework – that space actors have to abide by. Although much has been done over the years, the lack of clear national space laws and licensing regime in a number of space-faring countries is problematic, since it leads to many uncertainties for the private sector.

And while space may fire the dreams and imaginations of many a science fiction writer or reader, and some real-life space ventures have attracted a lot of interest, there is a lack of public awareness of the potential importance of the contribution that space could make to society in general. This can make it harder to move space up the political agenda.

An improved framework for space activities covering these areas could result in additional economic growth for OECD and non-OECD economies alike. ■

How to improve space's contribution to society?

If space is to make an increased contribution to society, it will involve an increasing variety of actors (see example in box). But action in three key areas could help improve the situation: a sustainable space infrastructure; greater public use of space services; and greater involvement of the private sector.

Developing and supporting a sustainable user-oriented space infrastructure

OECD work in recent years has shown clearly that efficient, robust and sustainable infrastructure, such as telecommunications or electricity networks, is essential for the smooth operation of modern economies. The same is true of civil space infrastructure, which is playing an increasing role in citizens' daily lives.

One obvious area is space infrastructure that is directly "user-oriented", such as communications, navigation and Earth observation services (such as weather forecasting). Governments could cut costs by using space services to meet demand across large geographical areas, for instance for delivering e-government services to all citizens in rural and remote areas.

Co-operation between governments, and between companies, could also help lower the cost of providing the "enabling infrastructure" for space activities, such as space transport and space manufacturing. International co-operation

Box 1:

SPACE AND HEALTH

Health care is one area where satellite-based technologies could provide solutions to many challenges facing society. Telemedicine and telehealth can extend the reach of medical care to populations in remote areas, disaster assistance teams, ships at sea etc, using technologies such as e-mail and telephones to transmit data and images and overcome geographical barriers to access,

Telehealth can keep health professionals informed of the most up-to-date findings, thus helping them treat their patients, can help co-ordinate services and can provide long-distance diagnosis and treatment advice for individuals or populations affected by a particular disease.

Several actors are involved in determining how telehealth systems operate and develop – satellite operators, healthcare institutions, public and private health insurers who will pay for the service, and telecommunications and health regulators.

Telehealth is in only limited use today, due to technical and institutional obstacles as well as questions over its cost-effectiveness compared to traditional health care delivery methods. But as health professionals become more familiar with its possibilities, demand is likely to rise, particularly as technological advances are likely to lower the cost.

In addition, increasingly mobile populations will require health services wherever they happen to be, and ageing populations will mean increased demand for home health care, much of which could be provided by telehealth.

in research and development could help reduce the cost of access to space, for instance. Companies can agree to share certain information while keeping key elements of their work confidential, a system that has worked in non-space sectors that have strong security constraints.

Fostering the public use of space services

Governments are major users of infrastructure, whether public infrastructure to deliver services to citizens or private infrastructure as an input in their activities. Sustainable space infrastructure could offer very attractive opportunities for pursuing a broad range of public missions in a cost-effective manner, if governments take full advantage of what is on offer.

At national level, governments need to strengthen co-operation between space agencies and ministries likely to use space-based services. For example, based on recent experiences of major flooding in Europe, it is clear that civil protection agencies have much to gain from using space data in user-friendly geo-information tools. At the international level, broad public measures can be promoted for using space solutions in case of disasters or monitoring treaty commitments in areas such as the environment.

But the key to any large-scale public service is a good financial footing. Innovative financial mechanisms will be needed if the full potential of space is to be exploited, as space agencies and the private sector cannot be expected to fund the increased use and operations of the space systems by a large community. In a perfect world, users should pay a minimum to help cover the expenses, but international collaboration will be key to allowing less developed countries access to space-related services.

Encouraging private sector participation

While space activities were essentially public at the beginning of the space age, the role of the private sector is rising. It is in the best interest of governments to ensure that private actors are encouraged to develop innovative applications that contribute fully to the economy and society at large.

To make this possible, governments need to implement or update national space laws to provide clear rules of the game, enforced in a consistent, fair and transparent manner for public and commercial space actors.

Empirical evidence suggests that countries that largely leave it to the private sector to produce goods and services tend to perform better, on balance, than those that do not. Leaving production to the private sector allows the public sector to concentrate on what it does best: providing public goods and services to the population at large and elaborating and enforcing effective rules of the game for private actors. Based on lessons learned in other sectors, governments should contract out to the private space sector as much as possible to spur growth while putting in place mechanisms for encouraging innovative small companies to take part. ■

For further information

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For further reading

OECD (2004), **Space 2030: Exploring the Future of Space Applications**, ISBN: 92-64-02032-2, € 35, 240 p.

OECD (2004), **Space 2030: Tackling Society's Challenges** ISBN: 92-64-00832-2, € 35, 334 p.

Visit the OECD International Futures Programme Web site at:
www.oecd.org/futures.

Working Papers related to the OECD Space Project are available at:
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