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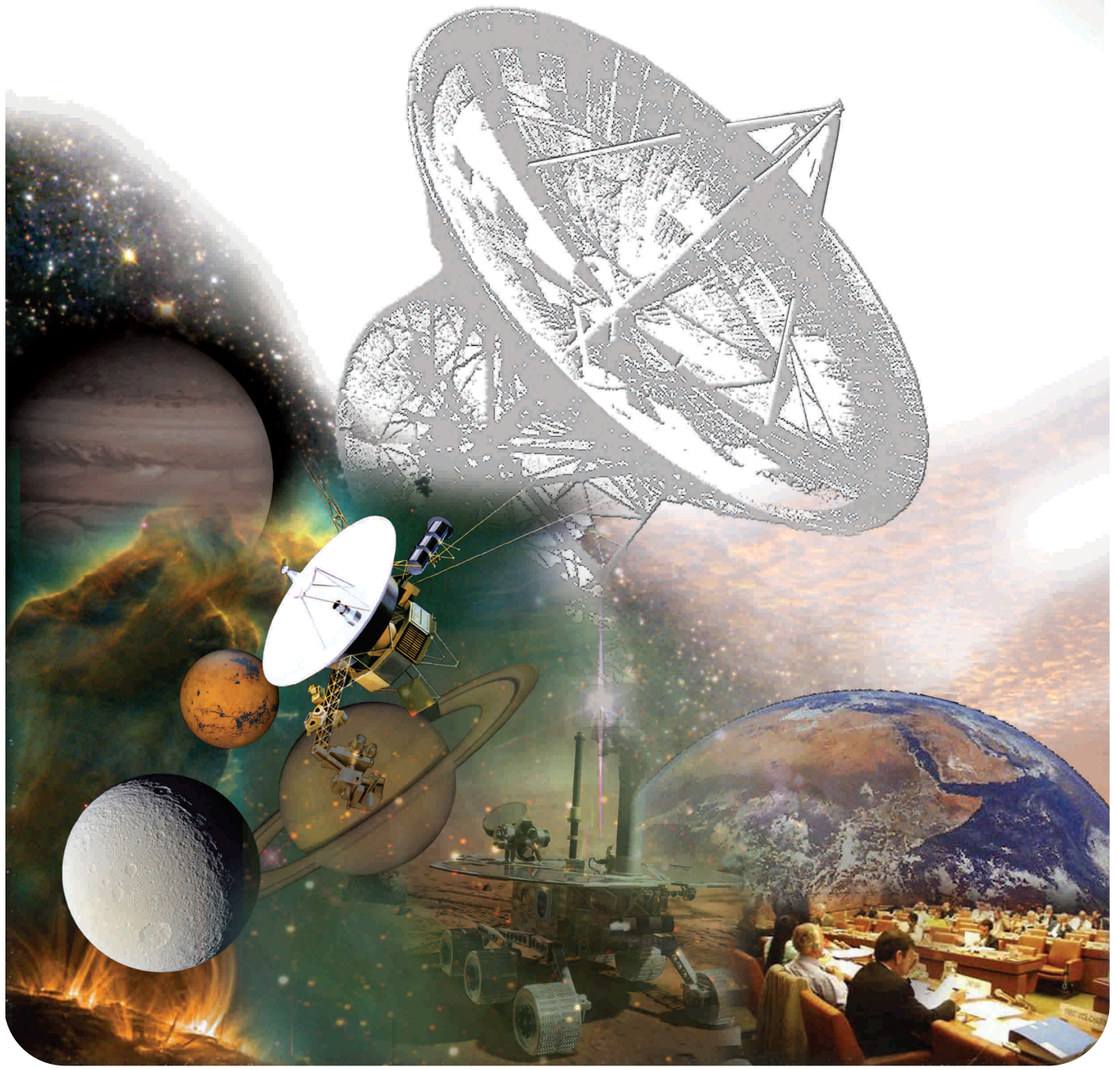
Trade and Industry
REPUBLIC OF SOUTH AFRICA

The International Space Landscape



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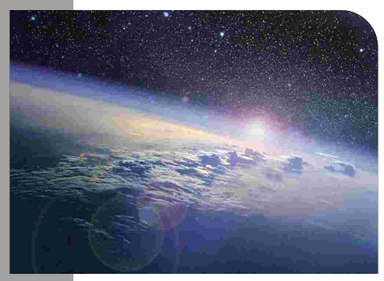
By their very nature, space activities are global in scope and reach. Hence space is considered to be a global commons, open for free passage and peaceful uses by all countries, and not subject to appropriation by any country.

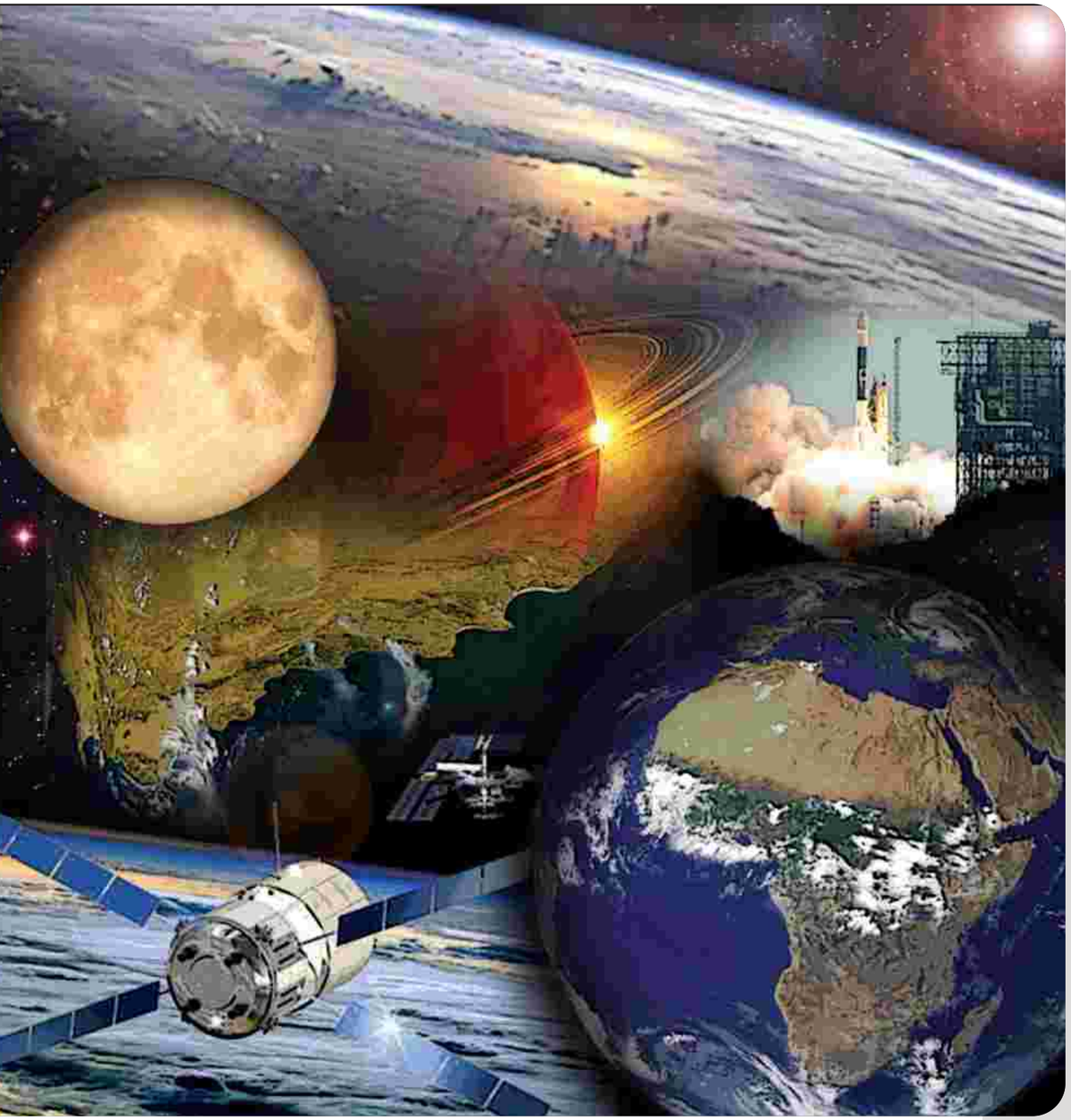
The number and diversity of actors in the space arena is increasing rapidly. In the earliest days of the Space Age, the global space arena was dominated by the two rival superpowers, the United States and the Soviet Union. By the end of 2007, 47 countries had placed satellites in Earth orbit, nine of them on their own, and the remainder in partnership with one of those nine countries. The actors in the space arena are no longer States and their space agencies, but also the military, the private sector and non-governmental organisations. With so many actors in the international space landscape, a number of intergovernmental and non-governmental fora have been established to facilitate cooperation and coordination.

This publication presents an overview of the international space landscape. It is one of a series of publications produced by the Department of Trade and Industry to provide the context and background for the South African Space Policy.

"Man must rise above the Earth - to the top of the atmosphere and beyond - for only then will he fully understand the world in which he lives."

Socrates
ca. 450 B.C.



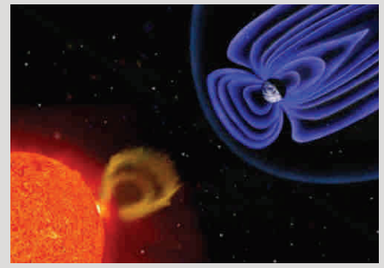


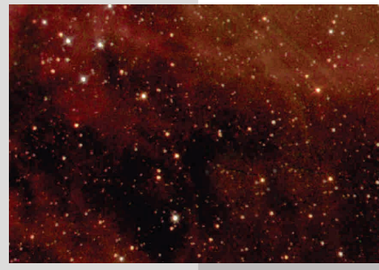
introduction

The international space landscape is dominated by a few major actors, namely the United States, Europe, Russia and Japan. These are the first countries that developed planetary exploration and human spaceflight capabilities. By whatever metric is used, the United States dominates the world space arena, with a combined civilian and military annual investment in space activities that exceeds that of all other countries combined. However, a number of other countries are entering the domain of the space powers. India and China are joining the exclusive club of nations with their own human spaceflight and exploration programmes. All of the countries in this group of advanced space faring nations have end-to-end capability to develop, build, launch and operate space systems of varying degrees of sophistication.

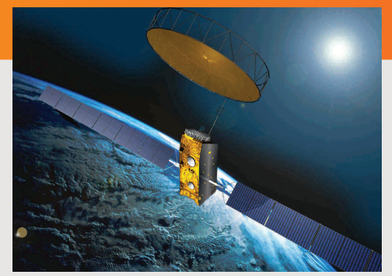
It is also possible to identify a group of intermediate space nations, which have considerable, but not yet comprehensive, space capabilities. Countries in this group typically have the means to design and develop their own satellites, with reliance on other countries for some critical subsystems or components, and for access to space. It is not uncommon for countries in this intermediate group to pursue research and development activities relating to launch vehicles. Examples of countries in the latter category include Brazil and the Republic of Korea.

The emerging space nations form a third distinct group. Countries in this group have nascent national space programmes to develop (typically) Earth observation or scientific satellites. The development activities normally take place in public sector research laboratories. Industry is involved in the manufacture of some of the systems, but there is significant reliance on the intermediate and advanced space-faring nations for access to technology and know-how. South Africa falls into this category, along with countries like Algeria, Egypt, Nigeria, Malaysia and Pakistan.





international cooperation in space activities

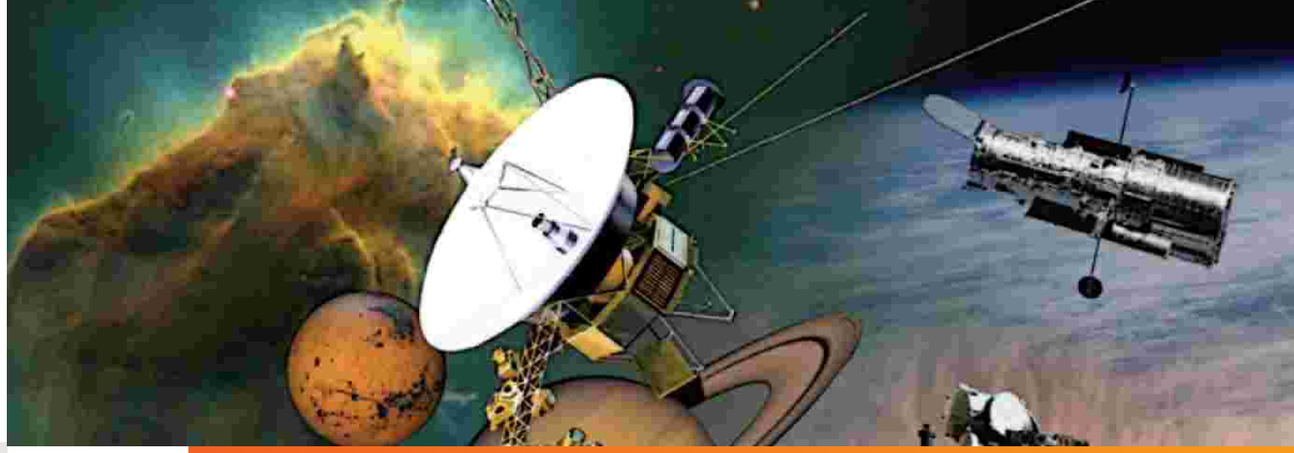


By their very nature, space activities have a global, and therefore international dimension. Since the earliest days of the space age, international cooperation has been a key element of space activities in most countries. Even during the Cold War, there was restricted cooperation between East and West in the space arena, and international multilateral fora, such as the international Committee on Space Research (COSPAR) and the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), were established to support international cooperation.

International cooperation has therefore become a central component in the space policies of many countries. States now rarely initiate space programmes without some significant component of international cooperation. The drivers for cooperation are manifold (political, scientific, economic, security, technical), but States cooperate when it benefits their own interests. The benefits include: cost and risk sharing, optimizing use of resources, gaining access to certain technical capabilities to enlarge the spectrum of possible missions, achieving foreign policy objectives, and so on. Space is also a domain for building political cooperation at global and regional level. Often cooperation along such lines takes the form of scientific cooperation in space activities. The Committee on Space Research (COSPAR) owes its Cold War origin to this category of cooperation between the rival superpowers.

A key element of successful space cooperation is that the cooperative activity must be aligned with the key interests of the partners. In an ideally balanced, symmetric cooperation, the contributions by and benefits to both partners are equal. In practice, such cooperations are very rare. The more advanced space-faring nations may enter into cooperative activities with emerging space nations as a way of building alliances, or developing new markets for their space industries. In these asymmetrical types of cooperation the more advanced space-faring State normally assumes responsibility for the more challenging cutting-edge aspects of the mission, knowing that it can "go it alone" if the cooperation fails for whatever reason.

Cooperation also adds additional risk and complexity to missions. Management of the cooperative activities adds an overhead to both technical and operational aspects of the programme. Such overheads can be considerable, both in terms of effort and cost. Partners may be unable to fulfil their obligations due to unforeseen technical, political or economic factors. The space landscape is thus replete with examples of cooperative projects that have encountered difficulties of such sorts. In addition to the above challenges, there may also be regulatory challenges faced by either one, or both partners.



rapid growth and diversification of space actors

In the first few decades of the Space Age, the key actors in the global space arena were States and their national space agencies. For the first 20 years the dominant players were the USA and the USSR. Though rivals, they played a key role in the development of the international cooperation landscape. The two superpowers were both concerned about arms control issues. This led to the 1967 Outer Space Treaty and to a ban on the placement of weapons of mass destruction in outer space. Cooperation between the two superpowers was sporadic and largely limited to symbolic actions, such as the Apollo-Soyuz docking in 1975. Intra-bloc cooperation was more regular and substantial, on both sides.

By the 1980s there were a number of new entrants into the space arena, with increasing technical capabilities. This led to a change from a bipolar situation to one of multiple poles, with increasing possibilities for international cooperation. Starting with one civilian space agency in 1958 (NASA), there were 36 national civilian space agencies by 2005.

It is interesting to note that for countries with strong international cooperation in space activities, national space agencies seem to be the preferred model for a national organizational structure to deal with space activities (as opposed to other models, such as a ministerial department, inter-departmental committee, and so on). The reason for this is that space agencies can readily identify their counterparts in other countries and negotiate with each other on equal terms. This partly explains why the number of national space agencies increased from 5 in 1970 to 36 by 2005. Another factor is the break-up of the Soviet Union into a number of independent states with space capability developed during the Soviet era.

The greater number of players has given rise to multiple new possibilities for cooperation. Existing cooperation axes have been strengthened and others have developed. A common feature of international cooperation among emerging space nations is that they all seek cooperation with the established space faring countries to benefit from transfers of experience and technology.

stages of cooperation

The evolution of space capabilities in countries follows a pattern as follows:

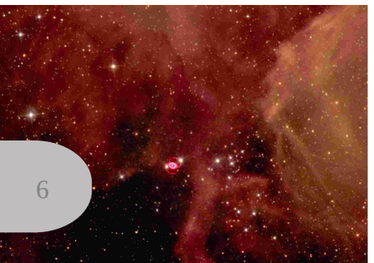
Stage 1: Purchasing satellites from established space faring nations, often with participation by scientists and engineers in the development and construction of the satellite. The focus of this phase is on technology transfer and creating a cadre of space technologists in the emerging space nation. In this stage cooperation is sought with more advanced space faring nations.

Stage 2: Establishment of satellite development facilities in the emerging space nation, often in cooperation with other established space nations. The focus of this phase is on transfer of operational and space project management skills, rather than technology transfer alone. In this phase the country also identifies those areas in which it aims to have autonomous capability, and begins to steer industrial development accordingly. In this stage cooperation is also broadened to other emerging space nations, especially in the area of satellite applications.

Stage 3: The country is capable of developing space systems independently, with inputs from other countries for systems deemed non-critical for autonomy, or not commercially viable to develop local industrial capacity. In this stage, a nation may start to disseminate knowledge of space systems development to other countries.

During each stage of development, there will be various perspectives and drivers for international cooperation.

The world is witnessing a multiplication and diversification of international cooperation possibilities. New centres of cooperation are beginning to emerge around Brazil and Argentina in Latin America, China and India in Asia. Some of these partnerships are beginning to break the mould of space cooperation established in the Cold War era. One example is the CBERS collaboration between China and Brazil. CBERS is making data available to third countries, including South Africa. Another interesting new dimension is that the newer players are being sources of cooperation possibilities for the established space faring nations. One example (of many) is the Indian Chandrayaan mission to the Moon, which is accommodating scientific payloads from institutions in Europe and the United States.



areas of cooperation

Space science provides a platform to demonstrate fruitful and peaceful cooperation in outer space. There are many examples of such cooperation among the leading space faring nations, often with a leading partner providing the main elements of a spacecraft and the other partners providing scientific instruments, or other components. This form of cooperation normally involves developing countries in the ground segment or scientific analysis of the mission data. Occasionally, there are thematic "international years" that provide added impetus to such activities, such as the International Geophysical Year 1957/8 at the start of the Space Age and the International Heliophysical Year 2007/8 fifty years later.

Since the productivity of science missions is effort-limited, there has been a trend in the past ten years to make data gathered in such missions freely available to the world scientific community in an attempt to maximise the scientific return from such missions. While this is certainly a form of scientific cooperation, it is not really a form of space cooperation, as it is sometimes referred to. However, numerous examples of true space cooperation exist between advanced and emerging space nations. One such example is the early Argentina – USA collaboration in the 1970s and 1980s. In such cases the collaboration has led to the development and growth of a set of space capabilities in the emerging space nation.

As Earth observation technology becomes more affordable and accessible, a greater number of states are becoming sensing states. Currently, 23 countries opperate their own Earth observation satellites. The emergence of commercial companies building microsatellites for the global market has brought this technology within reach of many more countries and has led to new possibilities for cooperation.

Global navigation satellite systems (GNSS) have their origins in the military requirement for precise navigation, but have found many commercially lucrative applications in the civilian arena. New GNSS are emerging that are more international in character (e.g. Europe's Galileo system). These, too, will contribute to the greater utilization of satellite-based position, timing and navigation services in developing countries.

growth of regional cooperation

As more actors enter the global space arena the potentials for regional cooperation will increase. Regional cooperation makes eminent sense in that it allows a group of countries with common concerns to pool their capabilities and resources to build regional autonomy and to accomplish collectively what they cannot individually. The key element to successful regional cooperation seems to be the emergence of one or more actors to take the lead. The most mature form of regional cooperation is one where the countries individually have significant space capabilities, but do not have the political will or economic means to "go it alone." The European Space Agency (ESA) was established in 1975 from the desire to combine European national capabilities into a critical mass that could complete with the USA and the USSR. ESA is an intergovernmental organization that has evolved very significant capabilities in space to serve Europe and its citizens. The 1990s saw the emergence of the Space Conference of the Americas (CEA) and the Asia-Pacific Space Cooperation Organisation (APSCO). These regional cooperative efforts are still in the stage of improving regional coordination and have not yet reached the stage of developing operational space programmes.

Perhaps the main difference between the European situation and that of Latin America and the Asia-Pacific region is that ESA was formed by countries with established (but very costly) space programmes, whereas this was not the case for the countries that formed CEA and APSCO. This may hold the lesson that regional space cooperation is most likely to succeed when a number of the partners have the technical means to "go it alone", but also the economic, technical and political motivation to cooperate regionally in order to compete globally. In this context the establishment of a regional structure for cooperation, such as an African space agency, may be best considered when there are a number of nations on the continent who commit substantial budgetary and other resources to the development, construction and operation of space systems. In the interim, other initiatives that build capacity through networks of regional institutions should be supported. One such initiative is the proposal in the NEPAD/AU Africa Consolidated Science and Technology Plan to establish an African Institute of Space Science as a networked organization. This will build on existing capacity in African institutions and provide a springboard for countries to develop their own capacity in areas of interest to them.

Within Africa, we are beginning to see the emergence of regional cooperation programmes, such as RASCOM, the regional African satellite communications initiative, and the African Resource Management (ARM) initiative among Algeria, Kenya, Nigeria and South Africa. The latter aims to develop a constellation of Earth observation satellites in which each country contributes one satellite to the constellation, but has access to data from the satellites of the other partners also. On a political level, African countries have established the African Leadership Conference on Space Science and Technology for Sustainable Development (ALC) as a forum to elevate the profile of space science and technology on the continent. The first ALC conference was hosted by Nigeria in November 2005 and the second by South Africa in October 2007. The ALC conference will continue to be held every other year in a different African country.

change from institutional space activities to commercial space activities

For the first few decades of the space age, the key drivers of space activity were national civilian or military institutions. In this scenario, industry developed certain capabilities to meet space programme requirements. As these capabilities matured (e.g. satellite communications) governments tended to outsource or privatize certain operational aspects that could be accomplished by commercial actors. Satellite communications was the first of the space application domains to mature to the point where commercial providers could develop profitable businesses. In terms of revenues, space telecommunication and broadcasting have the largest market share, followed by a rapidly expanding market for satellite-aided position determination, navigation and timing. Commercial space transportation had its genesis in the 1980s in the United States and has grown to include a number of actors in Ukraine, Europe, China and India. The United States Department of Commerce has established an Office of Space Commercialisation to develop a national strategic plan for space commerce. Other nations have started similar initiatives, albeit more modest in scope and objectives.

During the 1990s private sector expenditure on space systems exceeded national institutional expenditures and this is set to continue in the future. Governments will continue to provide the development effort and basic infrastructure and will use space for their own civilian and security needs. As industrial capabilities mature, the point is fast approaching where commercial space activities will begin to develop new systems and services that compete on a price basis in an expanding global market. All of this points to a future in which activities in space will become part of the spectrum of normal human activity, which is sustained by commerce and trade. It is interesting to recall the pattern of history in which exploration has inevitably been followed by settlement supported by exploitation of local resources and, eventually, commerce. There is every reason to expect that this pattern will eventually be continued in the space frontier.

Growing role of the private sector in capacity building

The private sector is playing an increasingly significant role in the emergence of nations in the space arena. Large international space companies and some very small companies are offering developing nations the opportunities to develop their own national satellites with a wide spectrum of possibilities, ranging from the supply of turn-key systems delivered in orbit, to the hands-on involvement of engineers from developing countries in the development of satellites, as well as various technology transfer programmes.

Technology transfer

A significant challenge confronting all countries in the space arena is that of access to technology and technology transfer. Part of the reason for this is the dual-use nature of space technology, much of which can be used for either civilian or military purposes. There are various regulatory measures and international agreements used to control access to such technologies, and these are often perceived to be highly restrictive by both providers and users of space systems. The important point for emerging space nations is not to "put all their eggs in one basket" and to diversify sources of technology as much as possible.

Another facet of technology transfer relates to the transfer of skills and technology for satellite development. A number of commercial actors offer development programmes for emerging space nations with a training and technology transfer component, but in practice the effect of such training is sometimes to produce knowledgeable customers rather that a cadre of scientists and engineers capable to duplicating the feat unaided the second time around.

shift in the centre of gravity of space policy making

Space policy-making is being shaped by many more actors and more dimensions than was the case in the early days of the space age. The emergence of commercial space actors is both changing the status of space from a special environment for scientific activities to an environment of commercial activities, with all the attendant legal and political problems that arise. To a certain extent the developments in space policy and space law are being outpaced by the technological possibilities. As more commercial actors enter the space arena, these possibilities will multiply and introduce further dimensions. For example, space debris generated by space activities has become a pressing problem for all operators of low Earth orbit systems. It is now commonplace for space agencies to execute collision avoidance manoeuvres of their satellites to avoid collisions with space debris. Already, some actors are advocating the development of frameworks to ensure the orderly and predictable conduct of activities in space, especially by users of the low Earth orbit environment. An example of this is the emerging discussion around the need to establish an internationally accepted set of space traffic management guidelines. As increasingly capable space systems are developed, the demands for power will increase, thus providing technical incentives to utilize nuclear power sources. The use of nuclear power sources in outer space raises a number of political and technical issues for debate.

South Africa's role in international space fora

United Nations Committee on the Peaceful Uses of Outer space (COPUOS)

The United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) is one of the standing committees of the United Nations. It was established in 1959 and currently comprises 69 Member States. South Africa is a Member State of COPUOS.

The mandate of the Committee is to promote international cooperation in peaceful uses of outer space; to devise programmes in this field to be undertaken under United Nations auspices; to encourage continued research and the dissemination of information on outer space matters; and to study legal problems arising from the exploration of outer space.

The Committee has two subcommittees, the Scientific and Technical Subcommittee and the Legal Subcommittee. The United Nations Office for Outer Space Affairs (OOSA) in Vienna runs the UN Programme on Space Applications, which is defined by the Member States of COPUOS. OOSA also provides the Secretariat functions for COPUOS.

Committee on Earth Observation Satellites (CEOS)

The Committee on Earth Observation Satellites (CEOS) comprises the world's government agencies responsible for civil Earth observation satellite programs, along with agencies that receive and process data acquired remotely from space. The membership of CEOS currently comprises 23 agencies, none of which are African. The dearth of African members is not surprising as the condition for membership is that CEOS members are "governmental organizations that are international or national in nature and are responsible for a civil space-borne Earth observation program currently operating, or at least in Phase B or equivalent of system development. Members must have a continuing activity in space-borne Earth observations, intended to operate and provide non-discriminatory and full access to data that will be made available to the international community."

The conditions for Associate membership are less stringent – namely that the organisation should have an Earth observation system under development or significant ground segment activity that supports CEOS objectives. There are 21 Associate Members of CEOS, of which the only African organisation is the CSIR Satellite Application Centre in South Africa. During 2008 South Africa was the Chair of CEOS and took the opportunity of its role as Chair to promote wider access to Earth observation data.

Group on Earth Observations (GEO)

The Group on Earth Observations (GEO) is coordinating international efforts to build a Global Earth Observation System of Systems (GEOSS) for monitoring and forecasting changes in the global environment by weaving together information from a diverse and growing array of instruments and systems. The GEOSS is intended to provide decision-support tools for nine Societal Benefit Areas, viz: Disasters, Health, Energy, Climate, Water, Weather, Ecosystems, Agriculture and Biodiversity. Clearly, all of these nine societal benefit areas are of critical relevance for Africa.

The membership of GEO comprises 73 countries and the European Commission. Of these, 16 (21%) are African countries: Algeria, Cameroon, Central African Republic, Republic of the Congo, Egypt, Guinea-Bissau, Mali, Mauritius, Morocco, Niger, Nigeria, South Africa, Sudan, Tunisia, Uganda. The activities of GEO are overseen by an Executive Committee comprising 12 members, of whom Africa is currently represented by South Africa (also one of the 4 GEO co-chairs) and Uganda. South Africa is implementing GEO activities on a national level through the South African Earth Observation Strategy (SAEOS), under the leadership of the Department of Science and Technology.

intra-african cooperation

Africa is central to South Africa's foreign policy. NEPAD and the African Union's (AU) African Ministerial Council on Science and Technology (AMCOST), founded in 2003, has designated space science and technology as one of five priority clusters. The African Leadership Conference on Space Science and Technology for Sustainable Development (ALC) has already started to facilitate contact and exchange of information amongst African space professionals.

Over the years, a number of regional institutions have emerged to promote cooperation in space applications in Africa. The Regional African Satellite Communications Organization (RASCOM) was founded in 1993 to establish African satellite communication capability. The first satellite, RascomStar-QAF, was launched in 2007. Unfortunately a mishap during launch resulted in the satellite having a far shorter operational lifetime than it was designed for. In the domain of Earth observation, the Regional Centre for Mapping of Resources for Development (RCMRD) was established in Nairobi, Kenya in 1975 under the auspices of the United Nations Economic Commission for Africa (UNECA) and the then Organization of African Unity (OAU). In West Africa, the Regional Centre for Training in Aerospace Surveys (RECTAS) was established in 1972 under the auspices of UNECA at the Obafemi Awolowo University in Ile-Ife, Nigeria. In North Africa, the Centre Régional de Télédétection des Etats de l'Afrique du Nord (CRTEAN) was established in Tunis in 1990 and comprises seven member states in the region.

In terms of education and training in space science and technology, in 1998 the United Nations established two Regional Centres for Space Science and Technology Education, one in Nigeria for anglophone African countries and the other in Morocco for francophone African countries. The African Regional Centre for Space Science and Technology Education in the English language (ARCSSTE – E) is situated on the campus of Obafemi Awolowo University, Ile-Ife, Nigeria. The Centre Régional Africain des Sciences et Technologies de l'Espace en Langue Française (CRASTE – LF) is situated in Rabat. The Centres have broad expertise in satellite remote sensing, telecommunications, space science and atmospheric science. They offer graduate and postgraduate training in these fields, carry out research and sponsor seminars, workshops and conferences.

Some African countries have already launched their national space agencies, such as Algeria (ASAL), Egypt (NARSS), and Nigeria (NASRDA), soon to be joined by South Africa's new National Space Agency. Scarce capital and human resources mean that some programmes, such as acquiring, processing, and sharing satellite imagery, can optimally pursued through continental cooperation. This is the long-term vision of the African Resource Management (ARM) constellation of satellites. The basic idea behind the ARM concept is that a number of African countries each contribute one satellite to the constellation, but can access all the other satellites as well. The ARM initiative is being led by Algeria, Nigeria and South Africa, who signed a Declaration of Intent to cooperate on the ARM project in July 2008.

south-south cooperation

One of the elements of South African foreign policy is South-South cooperation. In the space domain, aside from intra-African cooperation already discussed elsewhere, there are a number of potential collaborations with Asian countries, as well as with the Latin American countries. In Asia, potentials for cooperation in the space arena could be envisaged with countries such as India, Malaysia and the Republic of Korea. In the Latin American region, potentials for collaboration exist with Argentina, Brazil, Chile and Mexico, countries that all have emerging space programmes. South Africa is already in a partnership with Brazil and China to access Earth observation data from the Sino-Brazilian CBERS satellites.

Such South-South collaborations need not be limited to bilateral arrangements. The trilateral India-Brazil-South Africa (IBSA) partnership presents some interesting possibilities, since both India and Brazil have well-established space programmes. India has a mature capability for access to space and Brazil is well on the path to developing its capability in this area also. Another example is a world-class Indian research project to develop economical, reusable space launch vehicles, which would dramatically lower the cost of access to space. This holds promising possibilities for participation by both South Africa and Brazil's aerospace industries.