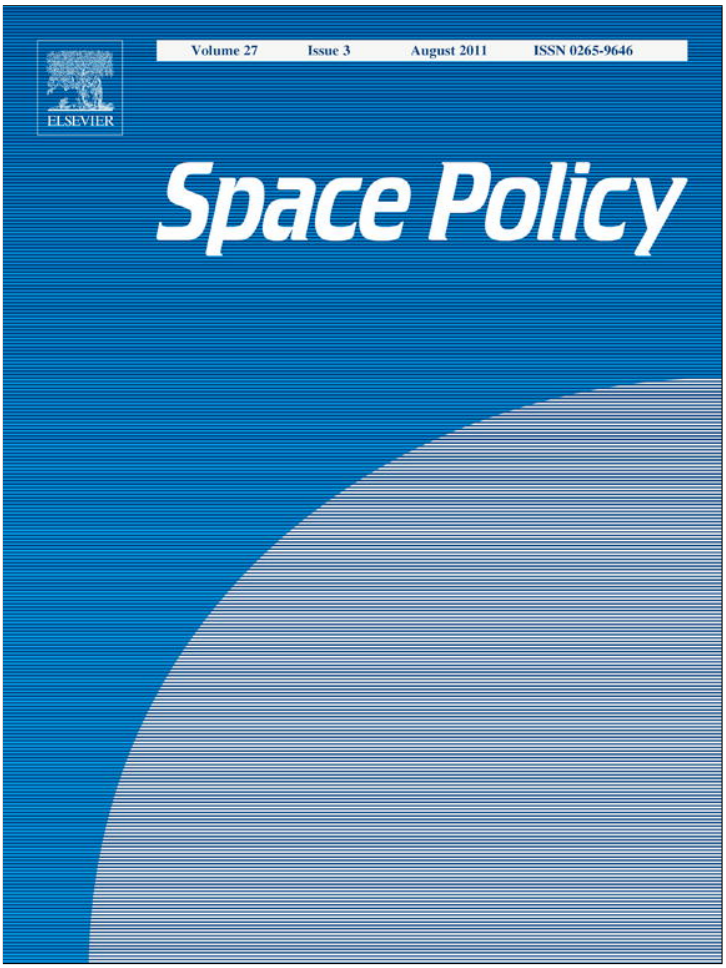

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# Space activities in the Bolivarian Republic of Venezuela

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ABSTRACT

This paper summarizes the establishment and current development of space activities in the Bolivarian Republic of Venezuela. Space activities in Venezuela are focused on the areas of telecommunications, Earth observation and research on the physical properties of the Earth, and have as a primary goal the satisfaction of social needs. Current development of space activities started in 1999 when the new National Constitution recognized the value of outer space as the common heritage of mankind, and the key role of science and technology in promoting human welfare. The Bolivarian Agency for Space Activities (ABAE) was created in 2007. Its legal framework recognizes three key elements that drive its policy: the participation of society, capacity building and human training, and international cooperation. Indeed ongoing international cooperation with partners such as China, India, Brazil and Uruguay has already expanded Venezuelan space capabilities, allowing the country to launch its first telecommunications satellite, Venesat-1 in 2008, to plan the infrastructure development for the design of small satellites, and to train 1195 local professionals in space science, technology and applications. Our analysis shows that Venezuela has the potential to become a space leadership country, promoting the social welfare, integration, and sustainable development of Latin American countries.



## 1. Introduction

The Bolivarian Republic of Venezuela has recognized the advantages that space applications can bring and has shown an increasing interest in developing local space capabilities for peaceful purposes. Thus, in order to provide national welfare, social inclusion and regional integration, since 1999 Venezuela has established a set of correlated actions intended to develop local resources in space science and technology, promoting technological independence and sovereignty [1]. This paper summarizes the establishment and current development of space activities in the Bolivarian Republic of Venezuela by describing governmental actions regarding the peaceful uses of outer space, the role played by the local space agency and international cooperation. The principles and focus of space activities in Venezuela, as well as the main outcomes, are also discussed. Most of the information herein has been gathered from research dissertations [1,2], public presentations or interviews with key personnel of the Bolivarian Agency of Space Activities (ABAE), and from internal draft documentation about Venezuelan space policy.

## 2. Growing governmental interest and the legal framework for Venezuela's space activities

Venezuela's initial interest in space matters was confined to endorsing the status of outer space as a common heritage of mankind and promoting the peaceful uses of it by becoming a party to the Test Ban Treaty, the Outer Space Treaty and the Agreement on the Rescue of Astronauts. However, more consistent actions were established at the end of the 1990s, and since then the country has shown an increasing interest in developing indigenous space capabilities for peaceful purposes. One of the main challenges faced by Venezuela during the 21st century is the consolidation and execution of public policies intended to satisfy social needs, which includes the government's decision to promote the peaceful uses of outer space [1]. Following this requirement, Venezuela's participation in the space field has embraced several steps, such as the legal framework established in the National Constitution of 1999, the creation of the Ministry of Science and Technology, the establishment of a Presidential Commission regarding the peaceful uses

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of outer space, and the creation of the Venezuelan Space Center. These have contributed to the development of space capabilities and the legal creation of the Bolivarian Agency for Space Activities (ABAE) in 2007 [1,2].

### 2.1. The National Constitution of 1999

As part of the legal framework for the development of space activities in Venezuela, Article 11 (on national territory) of the National Constitution of 1999 establishes that "The Republic has rights in Outer Space and those areas which are or might be a Common Property of Humanity, on such terms and conditions as may be determined by the international agreements and by the national legislation" [3]. For the first time the National Constitution recognizes the value of outer space as a common heritage of mankind and suggests the right to use it according to international agreements. This means that Venezuela does not claim sovereignty in outer space but asserts its right to use it in a peaceful way like any other nation in the world. This opened up the possibility for Venezuela to participate at the United Nations and other international fora to coordinate space activities with member states in accordance with international space law [2]. In general, the legal framework established in 1999 needed a governmental reorganization that promoted the creation of new institutions such as the Ministry of Science and Technology, which are still are helping to design strategic plans under the constitutional mandates of promoting social inclusion and welfare.

### 2.2. Creation of relevant bodies

The Ministry of Science and Technology was created in 1999 by legal decree N° 253. It is the governmental institution in charge of designing policies, plans and strategies to build an efficient system of scientific and technological production, promoting innovation, research and development (I, R&D) activities that will satisfy social needs, and improving the national production system [4]. This new vision emphasizes the role of science and technology as a powerful tool to promote Venezuela's development in all sectors (i.e. social) and at all levels (i.e. productive system) [2]. One of the main contributions of the Ministry of Science and Technology was the planning and coordination of future space activities in the country, supporting the innovation process and technology transfer. In sum, the National Constitution of 1999 basically established the fundamental criteria for the future participation of Venezuela in space activities, while the Ministry of Science and Technology was the governmental organization that helped to put into force the mandates contained in this advanced constitution regarding the use of space science, technology and applications to promote social benefit. One of the main achievements of the Ministry of Science and Technology was the coordination and setting up of a Inter-ministerial Commission for the peaceful uses of outer space in 2004.

The main objectives of the Inter-ministerial Commission were to unify and coordinate the national organizations with competences in space issues, to preliminarily asses the human talent and space capabilities available in Venezuela, and to determine the type of governmental organization that could coordinate future space activities in the country [2]. At the same time exploratory visits were undertaken to potential space partners such as China, India, Brazil, Argentina and Russia; these demonstrate the important role of international cooperation in the consolidation of space activities in Venezuela from early on. The Inter-ministerial Commission concluded that there was a need for a direct adviser to the President of the Republic on space issues. Thus, the creation of a Presidential Commission was proposed in 2004 [1].

This was created in December 2004 by legal decree N° 3.389 [6]; it was composed of one representative of the vice-presidency and nine ministries (Science and Technology, Defense, Communication and Information, Environment, Energy and Mining, Infrastructure, Planning and Development, Foreign Affairs, and finally Production and Trade). The main duties of the Presidential Commission were: to establish its own regulatory mechanisms to guarantee its proper functioning; to advise the President of the Republic on space issues; to promote space research in order to support governmental planning; to propose a legal framework that would help establish a permanent organization responsible for space activities; to promote international cooperation; and to assess the human talent and the space capabilities available in Venezuela [5]. The Presidential Commission was divided into four sub-commissions: technical, legal, Earth observation and human talent. The main achievements of the Presidential Commission were its regular advice to the president in order to support the decision-making process (including its assessment of technical tenders for the design, manufacturing and launch of a telecom satellites), its support for the project to create a Venezuelan Center of Remote Sensing (Centro Venezolano de Percepción Remota, CVPR), the identification of orbital slots, legal proposal for the creation of the ABAE, establishment of cooperation agreements with China, Uruguay and India, and its early actions in the Venesat-1 Program (contract assessment, coordination with national institutions, promotion). However, by law any Presidential Commission can only stand for one year. Thus, in order to fulfill Venezuela's commitments and to guarantee the continuity of space activities, in 2005 the establishment of a Venezuelan Space Center Foundation was proposed [1,2].

### 2.3. Creation of the Venezuelan Space Center Foundation (Fundación Centro Espacial Venezolano, CEV) and the Bolivarian Agency of Space Activities (ABAE)

The President of the Republic, Hugo Chávez, enacted legal decree N° 4.114 regarding the establishment of the Venezuelan Space Center [6], a governmental organization attached to the Ministry of Science and Technology, on 28 November 2005. The CEV took over the role of the Presidential Commission, and operated from April 2006 (date when was officially appointed the President of the CEV Dra. Nuris Orihuela) until 31 December 2007. During that time, it coordinated and executed space policies, and developed space and ground infrastructure to provide communication services, based on a new development model intended to meet social needs [7]. Among the main achievements of the CEV are:

- Projects such as the Venezuelan telecom satellites Venesat-1 (space segment, ground segment, and human training); Earth observation programs (boosting the project for the CVPR, human training); use of satellite applications to support decision-making processes in agriculture, health, environmental management, urban planning, disaster management, national security and defense.
- Diagnosis of space applications that could help satisfy social needs.
- Foundations for the establishment of the national space institution.
- Coordination among governmental organizations.
- Implementation of the international cooperation agreements with China, India and Uruguay, and negotiations with potential space partners such as Brazil, Argentina, Russia and France [1,2].

The establishment of technical commissions, and the regular exchange of information, documentation and expertise between

foreign and local personnel, are some examples of the key role played by international cooperation in the successful achievement of these goals, and in the consolidation of indigenous space activities. However, the Venezuelan Space Center Foundation was a temporary organization created while the National Assembly was discussing the legal creation of the ABAE, which was conceived by the Inter-ministerial Commission in 2004 as the organization that would be responsible for space activities in Venezuela [2].

On 9 August 2007 the National Assembly approved the law for the creation of the ABAE, which was officially published on 25 October 2007 in the GO N° 38.796; the law established that ABAE's activities must officially start on 1 January 2008 [8]. All the CEV's commitments were absorbed by ABAE, including assets and human resources, and from 1 January Dr. Nuris Orihuela was also appointed as the first president of the agency.

## 3. The Bolivarian Agency of Space Activities (ABAE)

Acting under the scope of the new Constitution of 1999, the current government has promoted the modernization of Venezuelan institutions based on the principles of social inclusion and justice. The aim is for more inclusive national organization guaranteeing efficient administration for the benefit of the whole of society. ABAE was created in this context. According to Article 2 of the law creating it, ABAE is an autonomous institution attached to the Ministry of Science and Technology [8]. This autonomous character embraces the financial, administrative, budgetary, organizational, technical, regulatory and resource management functions of the agency [8]. Among its main duties are:

- to design, develop and propose a National Space Plan;
- to design, develop, advise and execute plans, projects and programs consistent with the peaceful uses of outer space at national and international level;
- to design, develop, advise and execute plans, projects and programs regarding space I, R&D;
- to coordinate and execute space activities with other like-minded organizations, including operative and research centers;
- to guarantee the fulfillment of international agreements signed by the Republic that regulate space activities;
- to promote cooperation and harmony among national and international organizations, in order to support human training in space science and technology;
- to promote the development, reinforcement and expansion of the Venezuelan space industry;
- to promote the participation of the private sector and the other communities in the design and development of activities that would encourage space development in Venezuela;
- to make proposals and give advice to the President of the Republic and the Executive Power regarding international cooperation policy in space issues [8].

Some of the current achievements of ABAE include the establishment of the Venesat-1 satellite system, which is reinforcing the communication networks in Venezuela and providing telecom services to remote areas [9]. Furthermore, the agency is implementing several plans to use remote sensing technology to support social programs in agriculture, health, environment, urban planning, national security and defense, and natural disaster management [10].

In addition to the normal functions that any space agency in the world would perform, the legal framework of ABAE recognizes three key elements that constitute the core philosophy of the institution and drive its activities: the participation of society (i.e. organized communities, productive sector), the development of space capabilities through human training and technology transfer programs, and last but not least international cooperation. These three elements also reflect the strategic guidelines of the Venezuelan government, which is promoting a new development model based on social inclusion and participation, the establishment of peaceful alliances with international partners, and the technological independence of Venezuela.

## 4. Space activities in Venezuela

### 4.1. Principles and focus

The main principles of space activities in Venezuela are to [7]:

- promote the peaceful uses of outer space and technological development for life and peace;
- promote the development and growth of space capabilities in Venezuela through technology transfer and human training in order to achieve technological independence;
- coordinate and use space science and technology to satisfy social needs and support national programs;
- promote regional integration and cooperation.

In order to fulfill these principles, as well as to reinforce educational and health programs, natural resource management, disaster management, and security and defense (i.e. border surveillance and reliable communications), the focus of local space activities includes the areas of telecommunications, Earth observation and research on the physical properties of the Earth (e.g. soil investigation, Earth's gravity and magnetic fields, etc.).

### 4.2. Main outcomes

- Legal creation of ABAE in 2007.
- Establishment of international alliances with China, India, Bolivia, Brazil and Uruguay.
- Participation of key stakeholders in national space activities. ABAE coordinates and provides guidelines to facilitate their participation in national space activities [7].
- Development of space projects:
  - VENESAT-1 Program. After an agreement signed in November 2005, the China Great Wall Industry Corporation was contracted and responsible for the design, manufacture, development, testing and launch of a telecom satellite for Venezuela. The satellite, designed with a mission life of 15 years, was constructed by the China Academy of Space Technology based on the country's DFH-4 Bus, and launched in 2008 [9]. The Venesat-1 Program also included the construction of two ground stations (main and backup) and the teleport by local professionals assessed by Chinese experts, as well as 90 Venezuelans trained in China in space science and satellite operations. Currently the satellite is working within 100% of its nominal design capacity, and is being fully operated by local personnel.
  - Establishment of ground stations to download and process satellite images to assist decision-making processes in public organizations [11], including support for the CVPR.
  - Development of research facilities for small satellite technologies. The strategic development of space activities is in the medium term (2007–2014) considering the establishment of space I, R&D centers to design small satellites [11]. The goal is to promote research networks and the development of space projects with the participation of local productive sectors in fields such as materials science, electronics,

chemistry, engineering, telecommunications, education, informatics, geomatics and geophysics.

- Human training. To date one of the main achievements of the government and ABAE has been the training of 1195 local professionals in different fields of space science and technology (see Table 1).
- Research and development activities. In conjunction with the academic sector, ABAE is developing several research projects intended to produce maps of Venezuela's absolute gravity, gravity anomaly and total magnetic field anomaly from satellite data (results submitted for publication). Research activities also include interpolation methods for the processing delay of Venesat-1, space policy and management [9,12,13].
- On-line platform course "Space Teledetection Techniques for the Analysis of the Geographic Features of Schools" run by ABAE. The objective is to train primary and secondary school teachers in the use of satellite images to analyze the surrounding environment of educational centers, and to promote the participation of local communities in the development of public policies at local and national level.
- Strengthening the space curriculum in academic centers. In coordination with local universities ABAE has implemented the seminar "Venezuela and its participation in international cooperation scenarios regarding the exploration and peaceful uses of Outer Space"; the agency has also incorporated local undergraduate students as interns in space research and development activities. In addition, the Central University of Venezuela runs the courses "Design of Communication Satellite Systems" (undergraduate level) and "Satellite Communications" (postgraduate level).
- Reinforcement of the Seismological Network of Venezuela managed by the governmental organization FUNVISIS (Fundación Venezolana de Investigaciones Sismológicas) using the Venesat-1 satellite, which speeds up the government's response to earthquake monitoring and disaster management.
- Strengthening local space capabilities. As part of the ongoing project run by ABAE's Unit of International Affairs on "Institutional Strengthening and Human Training", in December 2010 the local space agency and EADS-Astrium finished Module I of the "Comprehensive Training in Space Science and Technology". The full training program includes three modules (Module I "Satellite Operations and Management", Module II "Satellite Engineering" and Module III "Space Project Management"), and its aim is to reinforce the space capabilities of ABAE personnel in these three areas.
- VRSS-1 Program (Venezuelan Remote Sensing Satellite). The last May 26th of 2011, the Ministry of Popular Power for Science, Technology and Intermediate Industries and the China Great Wall Industry Corporation signed a contract for the design, manufacture, development, testing and launch of the first Earth Observation satellite of Venezuela. The VRSS-1 Program also includes the construction of the ground infrastructure in Venezuela, technology transfer and human training.

## 5. International cooperation as a key element in the consolidation of space activities in Venezuela

Since the beginning of space activities in Venezuela international cooperation has played a key role and ABAE is involved in both bilateral and multilateral cooperation [10].

### 5.1. Multilateral cooperation

At the multilateral level, and more actively since 2004, Venezuelan statements at the United Nations Committee on the Peaceful Uses of Outer Space (UN-COPUOS) have been based on respect for and compliance with the principles established in international space law, such as the principle of free access to space on equal conditions for all states, irrespective of their degree of economic or scientific development, especially promoting the equitable and balanced use of orbital slots, and the non-appropriation and non-militarization of outer space including the Moon and other celestial bodies. Venezuela has also expressed the need to update international space law by including issues that threaten future activities in outer space, such as space debris and the use of nuclear power sources in orbits close to the Earth [2,14].

Venezuelan participation in COPUOS is focused in topics such as space debris, the equitable use of the geostationary orbit, use of nuclear power sources in outer space, the means of preserving the peaceful uses of outer space, the participation of non-governmental organizations within the Committee, space and society, and the long-term sustainability of outer space activities. All the Venezuelan statements reflect its view that any activity performed in outer space must be ruled by the principles of life preservation and peace [2,14].

### 5.2. Bilateral cooperation

For Venezuela international cooperation is not only an integration tool, but is also a mechanism to strengthen all the space plans,

**Table 1**
Summary of local professionals trained in space-related fields since 2006.

| Field | Country | Institution | Number | Observations |
|---|---|---|---|---|
| Telecommunication | China | Beihang University and Chinese Academy of Space technology (CAST) | 30 Professionals (doctorate alumni) | VENESAT-1 Program. Professionals already on duty in ABAE and other national institutions |
| Telecommunication | China | Beihang University and Chinese Academy of Space technology (CAST) | 60 Satellite controllers | VENESAT-1 Program. Controllers already on duty at the VENESAT-1 Ground Stations |
| Geomatics | Brazil | National Institute for Space Research (INPE) | 14 Professionals | Most of the personnel are already on duty in Venezuelan institutions |
| Geomatics | India | Indian Institute of Remote Sensing (IIRS) | 38 Professionals | Most of the personnel are already on duty in Venezuelan institutions |
| Space management | France | International Space University (ISU) | 1 Master alumni | Personnel already on duty in ABAE. Studies sponsored through the space cooperation with China |
| Geomatics | Venezuela | The Bolivarian Agency for Space Activities (ABAE) | 1052 | Courses for teachers and public employees |

programs, and projects promoted by the national government that aim to provide social benefit at national and regional level. Currently the Bolivarian Republic of Venezuela and its Ministry of Science, Technology and Intermediate Industries have signed cooperation agreements in space science and technology with Bolivia, Brazil, China, India, and Uruguay [10]. A more detailed description of these agreements (country, objective, scope, benefits) is shown in Table 2.

These cooperation agreements and their outcomes demonstrate that Venezuela is willing to actively participate in the space arena as a peaceful nation, promoting the integration and sustainable development of Latin American countries which share similar cultural, social, economic, political, and environmental realities [9]. For Venezuela international cooperation is a real integration tool (regional and transcontinental) that is helping it build its space capabilities. This kind of strategic alliance is perceived by member states as a win-win policy, which integrates regional and international space aspirations and development for peaceful purposes [1].

## 6. Discussion

The Bolivarian Republic of Venezuela has shown an increasing interest in developing local space capabilities for peaceful purposes because it recognizes that, by acting as a trigger technology, space technology and its spin-offs are powerful tools to develop indigenous industry and move the country's development forward. Furthermore, space applications in the areas of telecommunications, navigation and Earth observations can improve the living standards, connectivity, health and education of the people. These aspects of space technology are well understood by the developed nations today.

Venezuela has created a legal framework for the establishment of space activities, including a space agency, and has promoted indigenous competences wherever possible, while also acknowledging the importance of international cooperation in space. From the initial context in 1999 (which includes the Constitution and the formation of the Ministry of Science and Technology) to the legal creation of ABAE in 2007 international cooperation has played an increasing role in the consolidation of space activities in Venezuela. It started with a "First National Space Workshop" and has moved on to embrace membership in COPUOS and the International Telecommunication Union (ITU), further participation in workshops and courses, as well as the negotiation and completion of bilateral agreements with Bolivia, Brazil, China, India and Uruguay which support the legal mandate to build Venezuelan capabilities through technology transfer and human training. Currently, ABAE is negotiating the establishment of space cooperation agreements with Argentina (South America), France and Russia (Europe).

Thus, ABAE sets this approach as a key requirement of any space cooperation agreement negotiated with Venezuela. Following governmental guidelines, ABAE considers that technology transfer and human training are the most feasible way to develop space capabilities, and to break former dependency paradigms. Thanks to strategic planning and the right space partner, the strengths of the agreements signed by Venezuela-ABAE are obvious because they are promoting the transference of space knowledge, products, services, processes and industrial methods, space norms, standards, procedures and management tools, and at the same time are bridging the collaborative network of the agency and the team

**Table 2**
Summary of the agreements signed by Venezuela regarding the peaceful uses of Outer Space ABAE [10]

| Country | Agreement | Type of agreement/date | Objectives | Main deliverables |
|---|---|---|---|---|
| The Plurinational State of Bolivia | Memorandum of understanding for the development of activities of capacity building in science and technology for the exploration and peaceful uses of Outer Space. | Institutional agreement. Ministry of Science, Technology and Intermediate Industries (Venezuela) and the Ministry of Public Works, Services and Housing (Bolivia). Signed in Cochabamba (Bolivia) on March 31st, 2011. | To explore, promote, establish and consolidate activities for capacity building in science and technology regarding the exploration and peaceful uses of Outer Space, for the mutual benefit. | Activities currently under coordination by the parties. |
| The Federative Republic of Brazil | Agreement for the cooperation in space science and technology between the Bolivarian Republic of Venezuela and the Federative Republic of Brazil. | Governmental Agreement (Bilateral). Signed in Caracas (Venezuela) on 27 June 2008. | To promote cooperation projects regarding the exploration and peaceful uses of Outer Space, with focus on Earth Observation and its applications. To strength and exchange technical resources; to promote human training. | Professionals trained in geomatics. |
| The People Republic of China | Memorandum of understanding regarding the technical cooperation on the exploration and peaceful uses of outer space. | Institutional agreement. Ministry of Science and Technology and the Ministry of Communication and Information (Venezuela) and the China National Space Administration (CNSA). Signed in Caracas (Venezuela) on 01 January 2005. | To promote the international cooperation in space issues based in the principles of equity and mutual benefit. To strength and exchange technical resources and to promote the human training. | The Venezuelan Telecommunication Satellite VENESAT-1 (Simón Bolívar Satellite). Two Ground stations (main and backup) placed in Venezuela. Training of 90 Venezuelans. |
| The Republic of India | Memorandum of understanding regarding the cooperation in space science and technology. | Institutional agreement. Ministry of Science and Technology (Venezuela) and The Department of Space (DOS, India). Signed in New Delhi (India) on March 2005. | To promote the international cooperation. To promote cooperation projects regarding the exploration and peaceful uses of Outer Space based in the mutual effort. | Human Training at the Indian Institute of Remote Sensing, IIRS in Geomatic. |
| The Republic of Uruguay | Agreement for the shared uses of the Uruguayan orbital position 78°W to place the Venezuelan Satellite VENESAT-1. VENESAT-1 Program. | Governmental Agreement (Bilateral). Signed in Caracas (Venezuela) on 14 May 2006. | To promote the international cooperation. To guarantee the mutual use and benefits of the orbital position 78°W requested by Uruguay to the ITU, for the positioning of the Venezuelan telecom satellite VENESAT-1 | Right to use the Uruguayan orbital position 78°W to place the VENESAT-1 satellite. Uruguay would have the right to use up to 10% of the payload capacity. |

skills. An example of the consolidation of ABAE strategy regarding the transfer of knowledge is the Venesat-1 Program, for which Venezuelans (engineers and other fields) are being trained in China in space science and technology, and are acquiring the technical skills to operate the satellite and its ground stations; cooperation with India and Brazil has contributed to the training of Venezuelans in Earth observation [10,15].

However, technology transfer is a complex process and ABAE should open up its possibilities and look for new space partners that could help to reinforce the agency's policy. One option for Venezuela could be to reinforce South–South international cooperation (which is also a governmental guideline), exploring the space activities of developing countries and learning from their experiences. For instance, over the past few decades South Africa has cultivated indigenous space know-how and industrial capacities, and owns significant space-related ground infrastructure and experience in the handling of remote sensing data [16]. The sustainability of the South African Space Program has also been improved by distributing non-recurring development costs through commercial sales of systems, components, services and, potentially, applications [16]. Furthermore, the primary goals of this program are focused on education and capacity building to satisfy African priorities. An even better known example of local and autonomous development of space capabilities to satisfy social needs is found in the Indian Space Program.

For the Bolivarian Republic of Venezuela and ABAE, international cooperation is one of the options for putting in place the infrastructure and human skills needed to enhance national space capabilities [1], and to put an end to any mechanism of technology dependence. The next step for Venezuelan space policy is to develop small satellites to support sustainable development programs, and then new training plans will be necessary to increase knowledge in mission requirements, design philosophy, payload design, project management, team work and human resource development. However, the accumulated experience of Venezuelans during the ongoing Venesat-1 program and Earth observation activities (including research and development), as well as the increasing role of international cooperation are key features that will contribute to increasing mission success in future small satellite missions. Finally, if Venezuela continues its efforts to develop its current space program it will become a space leadership country, promoting the social welfare, the integration, and the sustainable development of Latin American countries.

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