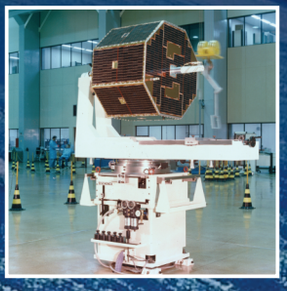
PNAE

NATIONAL PROGRAM OF SPACE ACTIVITIES 2012 - 2021



AEB
BRAZILIAN SPACE AGENCY

Ministry of
Science, Technology
and Innovation

GOVERNO FEDERAL
BRASIL

PNAE

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GOVERNO FEDERAL BRASIL

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Presentation

A country's sovereignty and autonomy are proportionally related to its capacity for technological development. Space technology is undoubtedly the most far reaching in this scenario.

Brazil is definitely committing to full sovereignty and autonomy by focusing, through the National Program of Space Activities (PNAE), on its priorities of integration of the space policy with other ongoing public policies, by promoting training, recruitment and retaining of qualified experts to boost our space activities, recognizing the need for mastery of critical and restricted-access technologies, with the industry's participation, along with the expertise and talent available in universities and national research institutes.

It is up to the State to use its purchasing power to mobilize industry for the development of complete space systems and encourage the creation of prime-contractor companies in the space industry, raising the space policy to the status of State Policy, establishing the strategic and geopolitical interest of space activities, which strengthen Brazil's autonomy and sovereignty.

The review of the National Program of Space Activities (PNAE), expected to take place only in 2014, has been anticipated, precisely because it welcomes these changes in the State's strategic environment, with new opportunities being created by the Federal Government, such as the program for the development of critical technologies; the technology absorption initiatives in the context of development of the Geostationary Defense and Strategic Communications Satellite (SGDC); new allocations of the Sectorial Funds; the National Defense Strategy (END); the initiatives of the Sectorial Technological Agenda (ATS) in connection with the Greater Brazil Plan; the special focus of the "Science without Borders" Program on the space area; legislative initiatives for the sector's tax relief, among other government actions.

And this is the result of a policy geared towards growth and development in Brazil, clearly demonstrated in the administration of President Dilma Rousseff, who resumed and confirmed her predecessor's commitment with the development of science, technology and innovation in the Country. Right now, in this new phase for the space area, the sector's national industries are called upon to play a key role, and the structuring and mobilizing projects defined by the Program will be the technology and research drivers capable of organizing a national supply chain and expanding the market for space goods and services.

The review work included extensive debate and participation of all the institutions that represent the space sector, and I would like to express my sincere thanks for their contribution: Ministry of Defense, through the Aeronautics Command; Aerospace Industries Association of Brazil (AIAB); Higher Council of the Brazilian Space Agency, and, to the latter, my special thanks, for having had the honor and great pleasure to preside it and to contribute to building this new path towards Brazil's space future.

Marco Antonio Raupp
Ministry of Science, Technology and Innovation


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A PNAE that dreams with its feet on the ground

This fourth version of the National Program of Space Activities (PNAE) is certainly more realistic than the previous ones, but it also has its eyes set on a horizon of dreams. It is realistic, because it seeks the path of concrete and productive achievement, based on the strength and creativity of industrial companies, mobilized by public policies and supported by expertise in universities and research centers. It dreams, because it seeks to promote strong changes in the spirit and way in which our space activities are conducted. It is a fair dream. It recognizes all the good that has been done, but at the same time aims to expand and accelerate much more all the good and fruitful actions that we must carry out in our space program.

The driving idea is not presumptuous, but it is not modest either. Big aspirations can not be totally unpretentious, however sensible they may be. The truth is that, in terms of space, we need to take a leap. A qualitative leap. A transforming leap. And with all possible haste. Developing our projects at higher speed is not merely an option, it is an urgent need. We must make use of the capabilities that we have accumulated and the precious opportunities that we have before us today.

We already do good basic science, also in the space area, and we have been moving forward in key fields. We already have good technology research centers, with increasingly competent performance. We are engaged in the battle for innovation, seeking to create and consolidate a culture that was generally absent throughout our history and our economy. What we still lack is a thriving, proactive, bold, groundbreaking space industry. We already have a brave group of small and medium companies hardened by everyday battles and even sacrifices. They are our foundation and our mainstay. We are not starting from scratch. But we must go further and cross the Rubicon. We also need, in particular, big companies capable of leading large-scale projects and designing huge achievements – that is, global-scale business, for the benefit of the country, the population, the national economy and our partners. A rich country is a country without poverty and that thinks big.

Our invitation to the developed world could not be different: let us cooperate with joint technological development, mutual interest and shared benefits. Nobody loses. Everyone wins. It is the rationale of common good. Is there anything better?

Space activities revenue exceeds US$ 280 billion a year worldwide. How to get closer to this fortune, with dignity and sovereign intelligence? It is one of the biggest challenges of the 21st century. And we're not dreaming a dream. We are dreaming a reality, unseen only by those who refuse to see.

José Raimundo Braga Coelho
President of the Brazilian Space Agency (AEB)

Highest priority: drive industrial progress

More than 50 years after the beginning of the Space Age, inaugurated with the launch of Sputnik I by the former Soviet Union on October 4, 1957, space activities have become essential to the daily life of every nation on Earth. The space industry provides increasingly more – and better – solutions, products and services. This, today, is one of our biggest challenges.

Brazil has a special vocation for space activities. With over 8.5 million km^2 of land, the country's territory totals 13 million km^2, including 4.5 million km^2 of sea. Its heritage, rich in natural resources of all kinds, needs to be increasingly identified, studied, monitored, managed, explored and protected in the best possible way. Space science and technology are vital to this effort. The industry has a historical role to fulfill.

This is a great challenge to innovation and entrepreneurship in Brazil: to meet the increasing space needs and demands in the country. That is, to enable the country to get the best use, in a sovereign and large scale way, of the benefits of the technologies, innovation, industry and space applications, on behalf of Brazilian society.

Therefore, it is imperative to prioritize the development and mastery of critical space technologies that are essential to industrial progress and the achievement of the necessary national autonomy in such a strategic activity. This mastery can only be achieved with intense and effective synergistic participation of government, research centers, universities and industries.

This new PNAE, focused on this joint endeavor, is the result of the review conducted by the Brazilian Space Agency (AEB) on the outcomes of the three previous PNAE (1996, 1998 and 2005), and inputs from important governmental and private institutions in recent years (box below). The analysis of the organization and functioning of the National System of Development of Space Activities (SINDAE), led by AEB, also enriched the document. This review has resulted in important and practical strategic guidelines.

Documents that contributed to this PNAE

- "The Brazilian Space Policy", produced by the Council of High Studies of the Chamber of Representatives.
- "Challenges of the Brazilian Space Program", published by the Secretary of Strategic Affairs of the Presidency of the Republic (SAE).
- "The Vision of AAB for the Brazilian Space Program", prepared by the Brazilian Aerospace Association (AAB).
- Proposed Evolution of the Brazilian Space Program for the 2011-2020 period, developed by IAE/INPE/AIAB, December 15, 2010.
- Contribution of the Aerospace Industries Association of Brazil – AIAB to the document: "Proposals for Reform of the National Program of Space Activities, AEB, June 30, 2011."
- Recommendations of the Aerospace Industries Association of Brazil – AIAB for the Industrial Policy – PNAE, May 2011.

What are the strategic guidelines?

1) Consolidate the Brazilian space industry, by increasing its competitiveness and innovation capacity, also through the use of the State's purchasing power and the partnerships with other countries.

2) Develop an intensive program of critical technologies in order to foster the capacity building in the space sector, with greater participation of academia, S&T governmental institutions and the industry.

3) Expand partnerships with other countries, by prioritizing joint development of technological and industrial projects of mutual interest.

4) Encourage funding of programs based on public and/or private partnerships.

5) Promote greater integration of the space activities governance system in the country, by increasing synergy and effectiveness of actions among its main players and the creation of the National Space Policy Council, conducted directly by the Presidency of the Republic.

6) Improve the legislation to strengthen space activities, by encouraging and facilitating government purchases, allocating more funds for the Space Sectorial Fund, and decreasing taxes to the industry.

7) Encourage the human resources development by training of experts needed in the Brazilian space activities, both domestically and abroad.

8) Promote public awareness on the relevance of the study, use and development of the space activities in Brazil.

Why space is vital for Brazil?

Space is indispensable to Brazil because we need more telecommunications, more know-how and better sustainable use of natural resources, enhanced monitoring of environmental and climate change, quicker and more efficient ways of facing natural disasters, improved surveillance of our borders and coastline, as well as reducing regional inequalities and fostering social inclusion.

All of this calls for the development of more space systems: in other words, more launches and launchers, more satellites, more information and images from space, more space activities and a more efficient and competent space industry.

The technologies required for earth observation, meteorology and telecommunications, along with the ability to access space autonomously, are now essential for the State to be able to fulfill its duties of monitoring and controlling the sustainable use of the environment and natural resources, such as water, crops and mineral reserves; to undertake weather and climate change research; to alert the population and Civil Defense about impending natural disasters, and to find ways of mitigating their effects; and to provide effective means for ensuring national security. All these activities require industry to play an active and dynamic role.

The Brazilian space industry is well aware of these requirements and as a result has undergone a number of significant changes. New increasing demands by the State, supported by major government investments, open to our Space Program unprecedented opportunities and challenges.

Widespread distribution of data from remote sensing satellites and suborbital launches – programs developed by INPE and the DCTA to meet the sectorial demands such as studying and protecting the environment and conducting research on microgravity – are practical examples of how space is essential for Brazil. We need to ensure that such programs continue to prosper.

The construction of the Geostationary Defense and Strategic Communications Satellite (SGDC), approved by the Government in 2011 to satisfy the demand for official strategic communications (both civilian and military) and to support the National Broadband Program (PNBL) – digital inclusion – is an important strategic initiative which will considerably boost our Space Program during this new and exciting phase of technological and industrial development.

The National Defense Strategy (END), in its turn, requires more capacity to monitor all our territory and our borders, including aerospace, with complete space systems, integrated with efficient ground infrastructure. Thus, more investment, more industry and more skilled jobs.

What can the Brazilian economy gain from space?

Our space industry has much to gain both domestically and internationally. The global space market is growing at an annual average rate of 6%, thanks to new demands for space applications and services, with new players and customers. In 2010, the world space economy revenue scored approximately US$ 276.5 billion, and it continues to grow. We have to be part of this business.

For example, our domestic market has a large variety of telecommunication companies and companies that process and add value to remote sensing images. More than 40 geostationary telecommunications satellites, all foreign, are operating in the country, using satellites manufactured abroad. Brazilian companies, along with foreign ones, provide only ground equipment and antennas for control stations and mobile TV services. Companies that process images use both free images generated by national satellites and paid images generated by foreign satellites.

We need to take better advantage of the prospects for growth of domestic demand for space products and services. This increase in demand follows a global trend, driven mainly by telecommunication services.

We need to increase our industry's participation in the manufacturing of launchers and satellites, which have been consuming around 30% to 35% (about R$ 102 million in 2011) of annual expenditures with our space program. Government projects should increase the industry's mobilization. The Geostationary Defense and Strategic Communications Satellite (SGDC), to be built by a joint-venture company created by the state owned Telebras and a branch of the airplane manufacturer Embraer, the Embraer Defense, will further enhance this path. This model shall be applied to other large-scale space demands of the country.

In short, we must work with a realistic portfolio of mobilizing and structuring projects, in order to meet the country's needs, shape a competent space supply chain, attract large prime contractor companies, and, thus, boost the market and our space activities in a sustainable manner.

What are our priority actions?

1) Meet the country's needs and demands for the space area, within agreed timelines and costs.

2) Integrate the space policy with other ongoing public policies.

3) Enhance human resources development by training, recruiting and retaining of qualified specialists in the numbers needed to strengthen our space activities.

4) Master critical technologies and restricted access technologies, with the industry's participation, and with the expertise and talent in universities and national research institutes.

5) Achieve the capacity to launch satellites from our territory.

6) Use the State's purchasing power to mobilize the industry to develop complete space systems.

7) Transfer space product technologies developed by research institutes to the industry.

8) Incorporate technologies, parts and processes developed and mastered by the Brazilian industry into the space systems commissioned by the State.

9) Engage the industry in all stages of development of space projects – from design to construction of equipment as well as complete space systems.

10) Encourage the establishment of prime contractor companies in the space industry.

11) Raise the Space Policy to the status of State Policy, establishing the strategic and geopolitical interest of space activities in the country and contributing to strengthen Brazil's autonomy and sovereignty.

12) Improve the integrated governance of the Brazilian Space Program.

What are the strategic actions to support the industry?

- Organize and strengthen the space industry's supply chain.
- Master the critical technologies necessary for our development.
- Expand the market for space products and services.
- Increase participation in international cooperation projects.

Why organize and strengthen the industry's supply chain?

Our space industry should be able to launch new products with increased added value. We need prime contractors - companies responsible for designing and developing complete systems. They have what it takes to increase and strength the supply chain's density by attracting small and medium companies; promote the emergence of new suppliers; attract partners from other industrial areas; and seek new markets abroad.

The prime contractors will strengthen the supply chains, based on skills developed by existing companies, protected by policies to support small and medium technology-based companies.

We should use more effectively the infrastructure and expertise available in our laboratories, such as INPE and DCTA, to add value and quality to private developments.

We need to promote industrial contracts to increase the maturity of certain technologies that are vital to operational programs. We should put out a tender for modules, equipment or subsystems capable of generating advances in relation to others or that contribute to national autonomy.

We also need to resort to the industry to reproduce equipment that has already been developed and qualified, that can meet part of the current demand at a lower cost, within shorter deadlines, while maintaining the industrial base active.

Why master critical technologies?

Because we need to overcome the barriers put up by certain countries to prevent us from having access to knowledge and commercialization of important space technologies. Such restrictions paralyze the development of our launch vehicles and satellites – projects that are always developed with peaceful purposes.

We must turn these barriers into an opportunity to develop and master technologies of high strategic interest autonomously, in our research institutes, such as INPE and the IAE of DCTA, in close partnership with industries and universities, including those in other countries.

We must master critical technologies that are:

- Difficult to obtain in the world market.
- Indispensable or relevant for the development of the missions that the country demands, conducted by Brazilian companies.
- Useful and stimulating for the consolidation of skills and facilities already available in the country, able to inspire renewed innovative impulses.

There are leveling, advanced and disruptive critical technologies. The impact of each on the Brazilian Space Program is as follows:

- Leveling technologies – which the world already masters – are essential to the development of systems and subsystems, but they are not suitably or sufficiently made available to

industries and research centers, nor are they easy to purchase in the world market.

- Advanced technologies – cater to the future of the Brazilian Space Program or the needs of existing programs, missions and projects, although they are still under development at the global level, and
- Disruptive technologies – emerge from radical technological innovations capable of inducingdeep changes in existing strategies. We need to pursue them.

To capture all these technologies, we must promote more scientific and technological missions, train more specialists and gain more low-cost access to space. We need to use low-cost orbital and suborbital platforms to test, demonstrate and commercialize new technologies and conduct scientific experiments. The goal is to industrialize and commercialize small satellites, launched by our own vehicles.

How to expand the market for space products and services?

We need to win customers in Brazil and in the world for the services and complete space systems coming out of our industrial supply chain. This is the main long-term industrial challenge for the Brazilian Space Program.

The economic benefits of space are strategic. Besides direct gains for the market, there are indirect ones, such as commercial advantages (space quality label) and technological advantages (spin-offs, and spill-overs), and benefits generated by indirect use of space information – such as models for numerical weather forecast and models and services resulting from the application of satellite images.

The number of players in the space market grows continuously with the expansion of increasingly accessible space applications. In the past, the market was limited to government institutions. Today, the private sector takes an increasingly active role in the supply of goods and services.

Brazil already shows signs of maturity and capacity in the development and production of certain space assets, such as sounding rockets. With products already qualified and demanded by the market, it's time to transfer them to industry. It's time for them to be manufactured and marketed. Also, the Multi-Mission Platform (PMM), under development, has a clear shot at commercial exploitation. It is versatile and its production cost is competitive.

But we still need to promote the culture of cooperation, capacity to innovate and to establish business ties and plans between the players involved in the space supply chain – research centers-business-government. This creative and stimulating practice will allow the private sector to play an increasingly central role of supplier of space systems and/or subsystems for domestic and foreign customers.

Why develop structuring and mobilizing projects?

Space programs in general only succeed and gain public recognition when they are leveraged by mobilizing and structuring projects, which focus efforts on clear and publicly defined goals that pose technological challenges for research and industry, and that organize a national supply chain and expand the market for space goods and services.

To this end, we envisage the following mobilizing and structuring projects, some already underway, others yet to be initiated. The list does not limit the initiatives of the Brazilian Space Program, and can be modified with additions or removals in the future:

- China-Brazil Earth Resources Satellites (CBERS-3 and 4 and those resulting from the Ten Year Plan for Space Cooperation)
- Amazônia Series of Remote Sensing Satellites (Amazônia-1 and its successors)
- Sounding rockets and reentry platforms
- Launch Vehicles based on the "Cruzeiro do Sul" Program
- Launch infrastructure for space access (CEA – Alcântara Space Complex) and commercial launch services (Brazil-Ukraine Agreement)
- Geostationary Defense and Strategic Communications Satellite (SGDC)
- Earth Observation Radar Satellite (SAR)
- Geostationary Meteorological Satellite (GEOMET)

Regarding the satellites, the projects listed above are geared to meet the country's major needs in the areas of Earth observation, meteorology, telecommunications and sciences.

As to the launch vehicles and launch pads, their development should seek to meet both domestic and foreign demand, compatible with the vehicles that will be operated from the Brazilian territory.

Along the 10 years of the current PNAE, we should focus efforts to develop, conclude and implement these space systems, together with the necessary ground infrastructure required for their integration and testing, operation, and data distribution.

Why and how to develop new skills?

The human resources development for the space area will ensure the sustainability and success of our space program in the coming years.

Today, we have six aerospace engineering courses in Brazil, all created in the last six years. And we need more.

The government is committed to fostering new skills through programs such as "Science without Borders", and creating new aerospace engineering courses. Nevertheless, there is pent-up demand for short-term hiring of specialists by leading research institutes in the space area to

replace qualified personnel that left or retired in recent years. Moreover, it should be noted that, in the medium term, with the progress of structuring projects, the industry will need to hire more specialists, which will require renewed efforts of the space program to better coordinate and integrate this supply and demand relationship.

We will need even more investment, in partnership with development agencies and other government institutions, in personnel training and refresher programs for the space industry, as well as programs for the scientific and educational communities and for society in general, to raise interest and generate new vocations for space activities.

Why is partnering with other countries important for Brazil?

Space cooperation in the form of partnership is growing worldwide. It facilitates and enhances investments, shares costs and risks, increases the number of projects, open new markets, strengthens and provides sustainability to the industry, increases the safety and reliability of products and services, and addresses regional and global issues.

Brazil has relevant space cooperation agreements. With China, we have a "global strategic partnership", thanks, among other initiatives, to the CBERS project – China-Brazil Earth Resources Satellite, initiated in 1988, to be extended by the Ten Year Plan for Space Cooperation, currently in preparation. With Ukraine, we created the binational company "Alcântara Cyclone Space" (ACS), for commercial launches using the Ukrainian vehicle Cyclone-4 from the Alcântara Launch Center (CLA). With Germany, we have been cooperating for 40 years and we now have the Atmospheric Reentry Satellite (SARA) project and the Microsatellite Launch Vehicle (VLM), a Brazilian proposal. We also work with Russia, France, USA, Argentina (SABIA-Mar and Multi-Mission Platform – PMM), India, South Africa, Japan, Italy and others.

For us, space cooperation in the fully globalized world of the twenty-first century is much more than a business transaction, it is about promoting joint scientific, technological and industrial development, with trusted partners, based on mutual interest, common effort and sharing benefits.

To this end, we have already mastered important space technologies and rely on specialized laboratories, launch centers in privileged geographical locations near the Equator, internationally recognized and qualified researchers, experts and technical staff, as well as a competent industrial base, which is still limited, but ready to grow.

The evolution of world politics has been helping us. The end of the Cold War and the successive economic crises have fragmented global political and economic power. New blocks are emerging in the Americas, Europe and Asia. A growing number of countries have space programs, albeit initially modest ones.

Brazil, Argentina, México, South Korea, South Africa, Kazakhstan, Ukraine and others have been creating their own technological capacity and increasing their space budgets in civil programs, by investing on average between 100 and 200 million dollars a year.

New players, such as Australia, Taiwan, Indonesia, Thailand, Malaysia, Bolivia, Chile and Venezuela, are investing 20 to 50 million dollars a year.

Why should we regulate our space activities?

More and more countries are adopting national laws to align their space activities with international standards adopted within the United Nations. Under Article 6 of the 1967 Space Treaty, each country is internationally accountable for its national space activities, whether undertaken by public or private entities. The country is responsible for authorizing – or not, such activities and keeping constant watch over them. Given the expanded space program that Brazil will conduct over the next ten years, we need to create a general law of space activities, with regulation that meets international standards in terms of space security, quality of products and services, as well as universally accepted agreements and contracts.

To this end, we need to consolidate the National System of Conformity Assessment in the Space Area (SINACESPAÇO), which aims to ensure the quality and safety of space activities in the country, and the Program to Support Standardization and Quality Activities in the Space Area (QUALIESPAÇO), which establishes technical standards to ensure the quality, safety and suitability of space products. This initiative is intended to support the first qualification flight of the Cyclone-4 and its launch platform, as well as other scheduled flights.

Standardization and certification of our space activities are vital and a high priority. They strengthen the management and work capacity of our space certification bodies.

What are the necessary investments?

The new PNAE will be implemented in two phases that are continuous and complementary. The first is a consolidation phase. During this phase, we will conclude projects already started in the past and initiate others, in order to expand and consolidate a set of actions to increase industrial capacity and technological mastery, develop skills and regulate space activities, which will create better conditions for ensuring greater sustainability for the program.

The second is an expansion phase. In this phase, we will initiate and develop new projects, with more complex technology and high strategic value, posing new challenges to the program. By then, we will count on fully developed integrating companies, a more structured supply chain, access to space available, a broader technological base and a much larger team of trained specialists.

In order to implement all the proposals envisaged in this PNAE, which covers no less than ten years, we need R$ 9,1 billion, with 47% allocated to satellite mission projects, 17% to space access projects, 26% to space infrastructure and 10% to other special and complementary projects, as shown in Table 1.

Table 1 – Investment Program

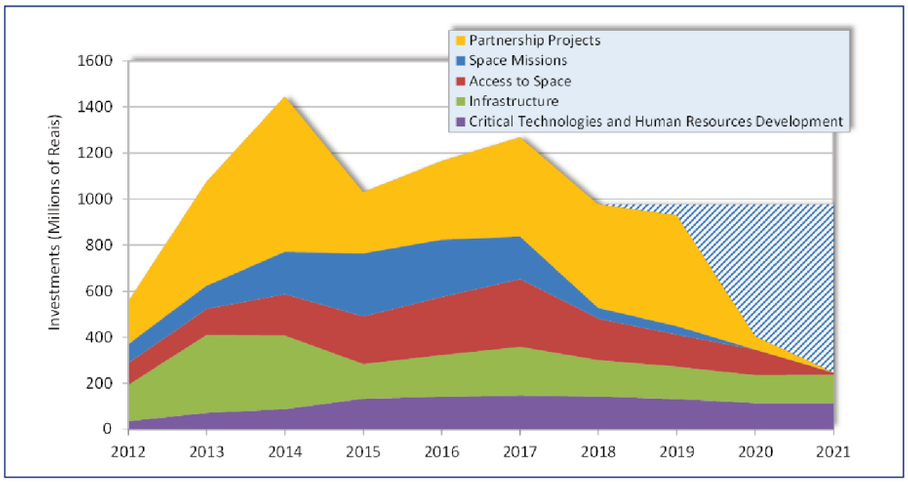
(In Millions of Reais)

		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TOTAL
SPACE MISSIONS		81,4	100,2	183,6	273,9	248,6	184,9	45,6	36,8	0,0	0,0	1154,8
Consolidation Phase	CBERS Satellite series	45,0	34,7	53,7	24,0	15,3	6,0	6,0	0,0	0,0	0,0	184,6
	Amazônia (1 and 1B) Satellite series	35,9	52,3	54,1	45,0	38,5	26,0	0,0	0,0	0,0	0,0	251,9
Expansion Phase	Amazônia-2 Satellite	0,0	8,8	39,6	66,0	49,2	35,3	12,3	12,3	0,0	0,0	223,2
	Lattes Satellite	0,0	3,9	17,1	49,9	71,0	73,6	2,8	0,0	0,0	0,0	218,2
	SABIA-Mar Satellite	0,5	0,5	19,1	89,0	74,7	44,1	24,5	24,5	0,0	0,0	276,9
ACCESS TO SPACE		94,2	112,4	179,6	206,7	252,2	294,2	180,2	139,2	110,2	9,2	1578,1
Consolidation Phase	Sounding Rockets	19,2	19,2	30,2	9,2	20,2	9,2	20,2	9,2	20,2	9,2	166,0
	VLS-1 Launch Vehicle	62,5	45,7	35,4	11,5	0,0	0,0	0,0	0,0	0,0	0,0	155,1
	VLM-1 Launch Vehicle	10,0	25,0	25,0	20,0	20,0	15,0	0,0	0,0	0,0	0,0	115,0
Expansion Phase	VLS-Alfa Launch Vehicle	2,0	19,0	33,0	98,0	130,0	120,0	40,0	0,0	0,0	0,0	442,0
	VLS-Beta Launch Vehicle	0,5	3,5	56,0	68,0	82,0	150,0	120,0	130,0	90,0	0,0	700,0
INFRASTRUCTURE		156,9	339,3	319,9	150,0	181,0	211,0	158,0	141,0	122,0	123,0	1902,1
Infrastructure and Operation of the Space Missions		17,2	31,0	60,0	60,0	61,0	61,0	38,0	41,0	42,0	43,0	454,2
Space Access Infrastructure		24,7	28,3	30,0	50,0	80,0	110,0	80,0	60,0	40,0	40,0	543,0
Specific Infrastructure of Alcântara Cyclone Space		15,6	206,7	127,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	349,6
General Infrastructure of the Alcântara Launch Center		99,4	73,3	102,6	40,0	40,0	40,0	40,0	40,0	40,0	40,0	555,3
CRITICAL TECHNOLOGIES AND HUMAN RESOURCES DEVELOPMENT		36,0	70,8	87,1	132,9	141,1	147,0	142,2	131,0	113,4	113,5	1114,9
Critical Technologies		22,5	47,5	52,5	57,5	62,5	67,5	72,5	77,5	82,5	87,5	630,5
Small Satellites		5,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	95,0
Scientific and Technological Missions		0,3	0,3	9,6	50,4	53,6	54,5	44,7	28,5	5,9	1,0	248,5
Research in Space Science and Climate		5,2	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	10,0	95,0
Human Resources Development		3,0	3,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	46,0
TOTAL		368,5	622,6	770,2	763,5	822,9	837,1	525,9	447,9	345,6	245,7	5749,8
PARTNERSHIP PROJECTS		186,0	452,4	676,0	266,3	341,9	431,2	451,0	481,5	57,5	0,0	3343,8
Consolidation Phase	Alcântara Cyclone Space (with MCTI)	130,0	164,9	164,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	459,8
	SGDC-1 Satellite (with Telebras and MD)	56,0	250,0	410,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	716,0
	Data Collection Satellite (with ANA)	0,0	30,0	60,0	40,0	20,0	0,0	0,0	0,0	0,0	0,0	150,0
Expansion Phase	GEOMET-1 Satellite	0,0	1,0	3,0	150,0	200,0	250,0	100,0	0,0	0,0	0,0	704,0
	SGDC-2 Satellite	0,0	0,0	0,0	0,0	0,0	56,0	250,0	410,0	0,0	0,0	716,0
	SAR Satellite	0,0	6,5	38,1	76,3	121,9	125,2	101,0	71,5	57,5	0,0	598,0
OVERALL INVESTMENTS		554,5	1075,0	1446,2	1029,8	1164,8	1268,3	976,9	929,4	403,1	245,7	9093,6

These investments, presented in large project groups in Figure 1, indicate the need, in the long run, to maintain a level of annual resources of R$ 900 million, essential to generate the necessary growth and sustainability of our space sector. This will increase both the industry's participation –

Figure 1 – Evolution of Investments

(In Millions of Reais)



with the creation and organization of the required supply chain of developers, integrators and vendors – and academic participation with research, development and training of qualified specialists.

To reach this level, our program needs to "capture" the demands, needs and interests of public and private segments and link them with other actions that enable their funding.

The Geostationary Defense and Strategic Communications Satellite (SGDC) project, implemented by the Ministry of Communications and Telebras, Ministry of Defense, Ministry of Science, Technology and Innovation, AEB and INPE, serves as a model for conducting other strategic projects, such as a synthetic aperture radar satellite (SAR) and a geostationary meteorological satellite (GEOMET).

What does the Country gain with all this effort?

For all the projects defined as structuring and mobilizing, the following outcomes and impacts are expected:

Mobilizing and Structuring Projects	Outcomes/Impacts
Geostationary Defense and Strategic Communications Satellite (SGDC)	• Establishment of a company that integrates space systems and a better structure and organization of the space sector's supply chain. • Increased technological capacity of the national industry in the segment of telecommunication satellites and increased rate of national participation in the development and manufacture of the second geostationary satellite.
China-Brazil Earth Resources Satellite (CBERS)	• Expansion of capacity for observation and monitoring of the national territory. • Continued and expanded cooperation with China, especially with the Ten Year Plan for Space Cooperation to be prepared.
Geostationary Meteorological Satellite (GEOMET)	• Reduction of foreign dependence in obtaining meteorological information on the national territory. • Expansion of technological capacity of the national industry in the segment of geostationary satellites.
Earth Observation Radar Satellite (SAR)	• Complements the capacity to observe the national territory from space, allowing observation regardless of weather conditions.
Amazônia Series of Remote Sensing Satellites	• Expansion of capacity for observation and monitoring of the national territory. • Mastery of critical technologies of navigation, attitude control and propulsion. • Brazil's insertion in the market of small remote sensing satellites.

Mobilizing and Structuring Projects	Outcomes/Impacts
Launch Vehicles	• Ensure the access to space. • Development of a microsatellite launcher (below 100 kg), for commercial purposes (VLM). • Mastery and technological capacity to develop larger launchers to meet the launch demands of the Brazilian Space Program (VLS-Alfa and VLS-Beta).
Sounding rockets and reentry platforms	• Brazil's insertion in the market of sounding rockets and scientific and technological missions exploring the microgravity environment.
Launch infrastructure for space access (CEA) and commercial launch services (Brazil-Ukraine Agreement)	• Ensures Brazil's capacity for autonomous access to space for large systems, through the binational joint-venture company Alcântara Cyclone Space (ACS). • Brazil's insertion in the world market for commercial satellite launching.

In addition to mobilizing and structuring projects, the program includes other complementary activities and projects that improve the sustainability of our Space Program. The expected outcomes and impacts are:

Complementary Projects	Outcomes/Impacts
Critical Technologies Program	• Increased capacity for coordination between government, academia and industry, helping to expand the country's technological autonomy, as well as opportunities for innovation in various sectors of the space area. • Development of human skills in the space sector. • Consolidation and expansion of aerospace engineering courses in Brazil.
Low-cost technological projects for small satellites	
Low cost alternative technologies project for access to space	

Satellite and launchers projects and their estimated launch dates are shown in Figures 2 and 3. The details of each project are found at the end of the document.

Figure 2 – Space Missions Schedule.

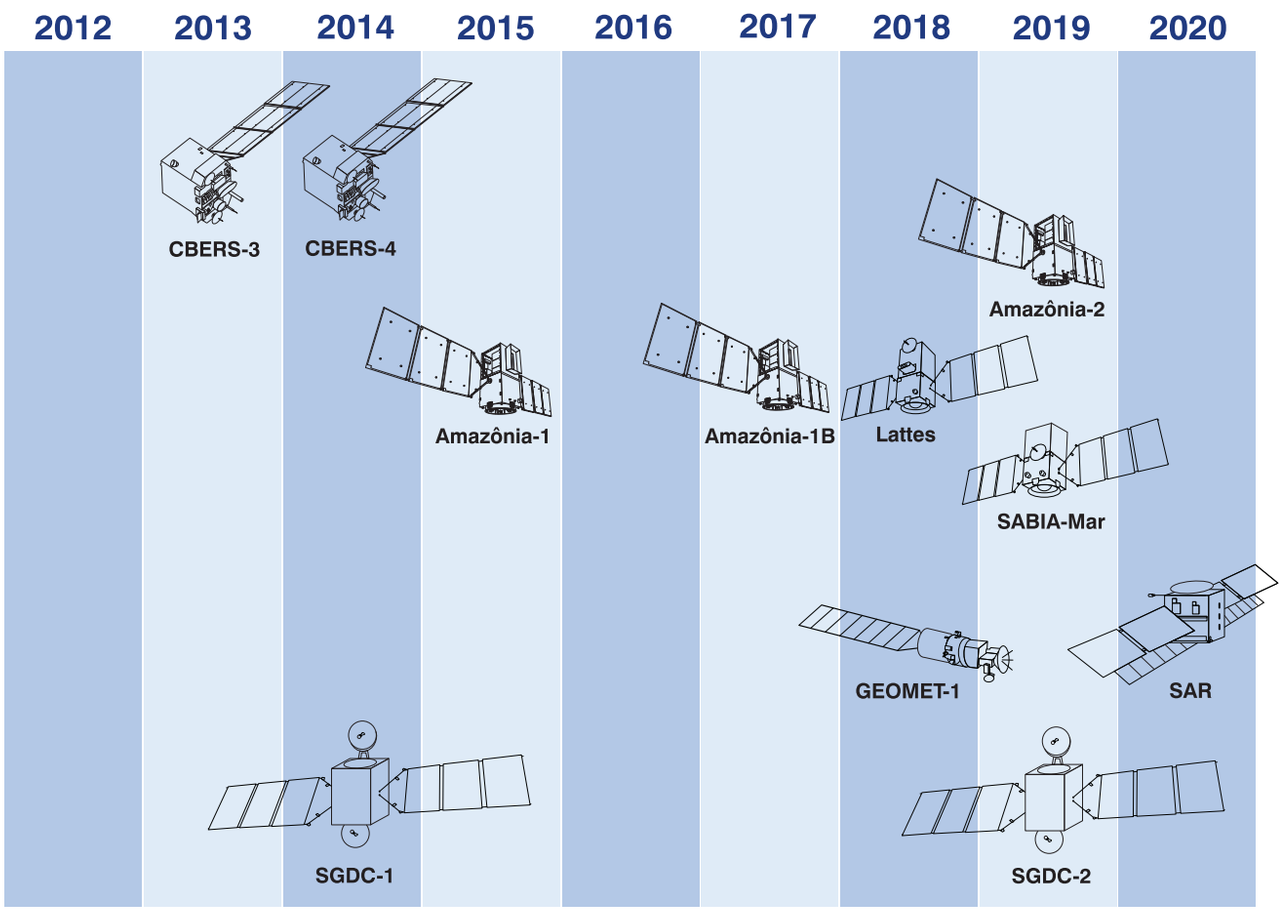
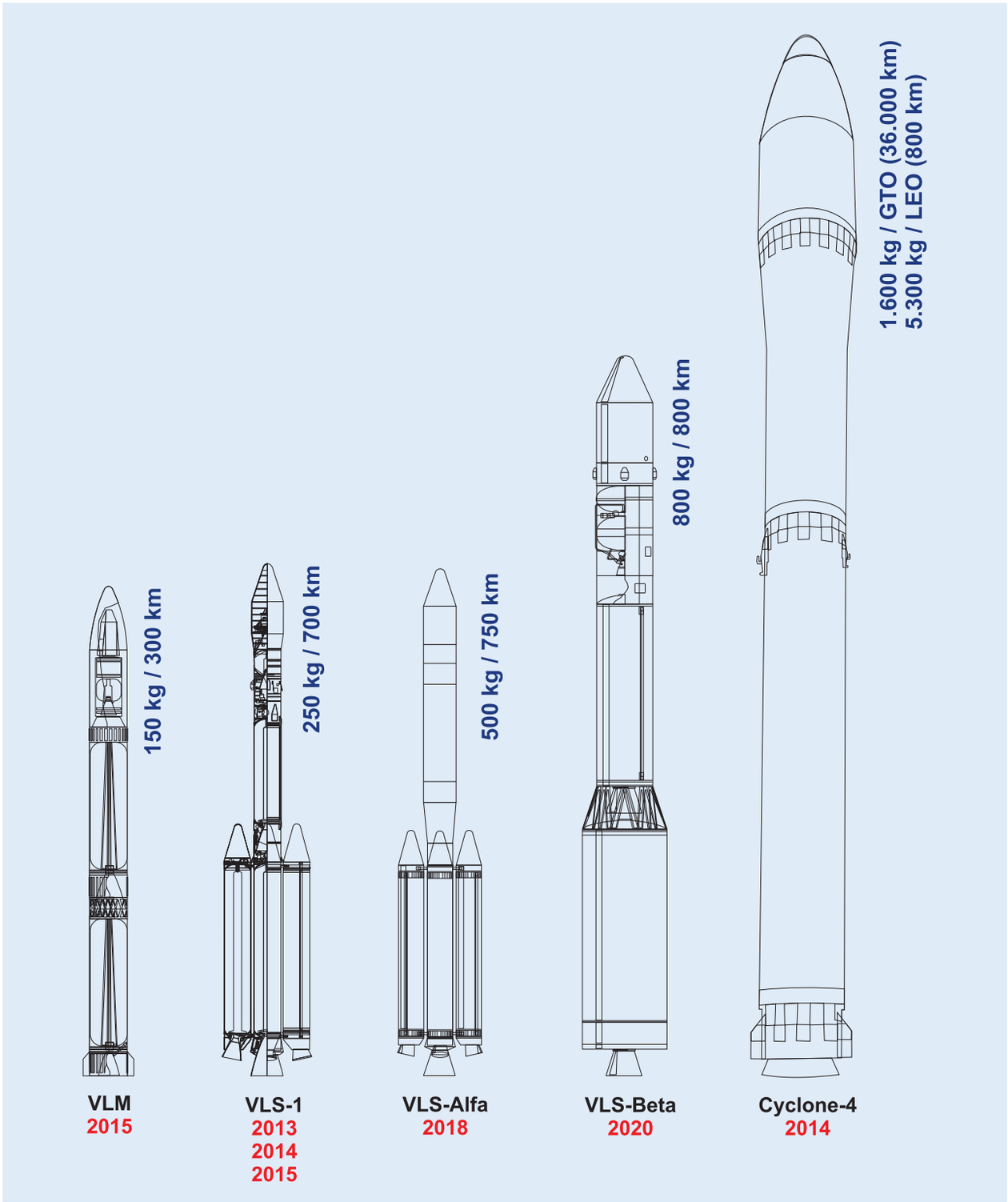


Figure 3 – Access to Space Projects Schedule.

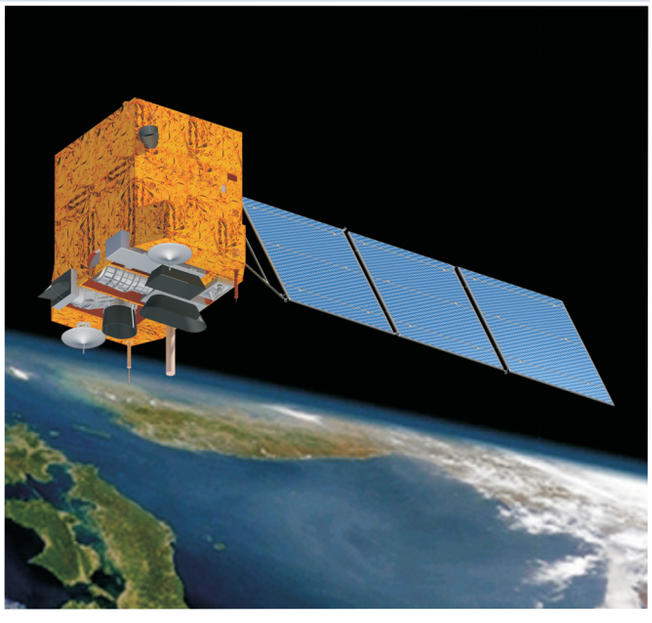


Project	China-Brazil Earth Resources Satellite (CBERS)
Applications	• Generate Earth images from space for use in agribusiness, environment, defense and other purposes.
Strategic Objectives	• Enable the country to observe the national territory and other regions of the Earth autonomously. • Increase the technological base of the national industry and its innovation and competitiveness capacity in domestic and foreign markets. • Strengthen international strategic partnership.
Users	• INPE • Government bodies and agencies focused on environmental protection and natural resources management. • Image processing companies.
Planned Launches	• CBERS-3: 2013 • CBERS-4: 2014
Participating Companies	• Aeroeletrônica, Cenic, Equatorial, Fibraforte, Funcate, Mectron, Omnisys, Opto Eletrônica, Orbital, Neuron
International Partnerships	• China

Features

Medium resolution remote sensing satellites equipped with optical payloads operating in the visible and infrared spectrum with resolutions ranging from 5 to 70 meters.

More information at:
http://www.cbers.inpe.br/



Project	Amazon Satellite series
Applications	• Generate Earth images from space for use in agribusiness, environment, natural resource monitoring and other purposes.
Strategic Objectives	• Enable the country to observe the national territory and other regions of the earth autonomously. • Increase the technological base of the national industry and its innovation and competitiveness capacity in domestic and foreign markets • Encourage innovations such as the development of high performance cameras and equipment that comprise the satellite platform.
Users	• INPE • Government bodies and agencies focused on environmental protection and natural resource management. • Image processing companies.
Planned Launches	• Amazônia-1: 2015 • Amazônia-1B: 2017 • Amazônia-2: 2019
Participating Companies	• Atech, Cenic, Fibraforte, Mectron, Omnisys, Opto Eletrônica
International Partnerships	

Features

Medium resolution remote sensing satellites equipped with optical payloads operating in the visible spectrum with a resolution of approximately 40 meters.

More information at:
http://www.inpe.br/produtos_servicos/engenharia_satelites/amazonia1.php

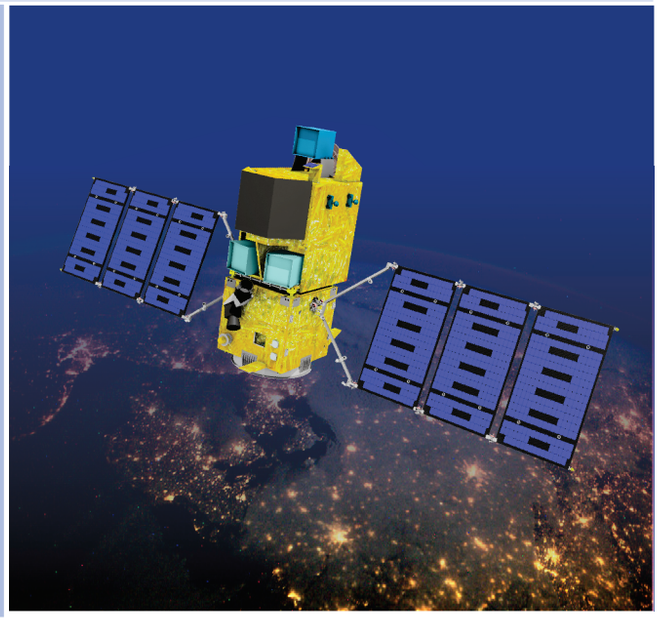
Project	Lattes Satellite
Applications	• Research on outer space phenomena.
Strategic Objectives	• Develop capacity to conduct studies of outer space, from our own scientific satellites. • Increase the technological base of the national industry and its innovation and competitiveness capacity in domestic and foreign markets.
Users	• Scientific community.
Planned Launches	• 2018
Participating Companies	• Atech, Cenic, Fibraforte, Mectron, Omnisys, Opto Eletrônica
International Partnerships	

Features

Scientific satellite with the following mission:

- Monitor the equatorial region of Earth's atmosphere to support studies of the phenomena that occur in our atmosphere and their relationship with space weather and meteorology;

- Research in astronomy, designed to monitor and collect images of a region of the sky with very rich X-ray emitting sources.



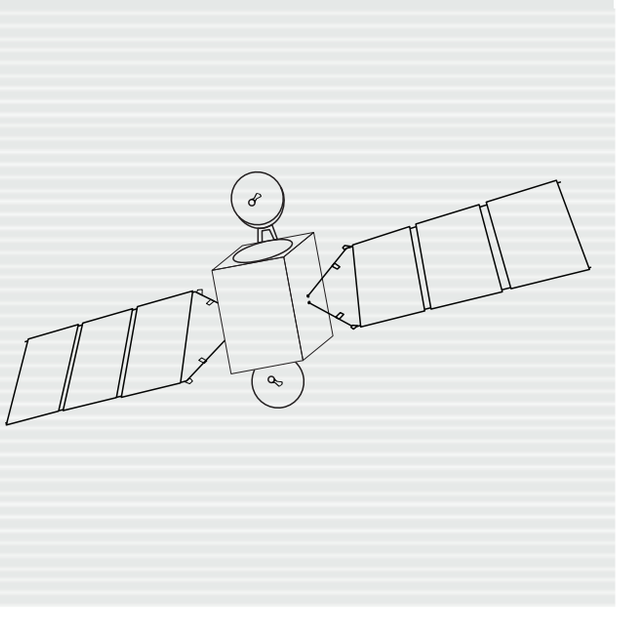
Project	Geostationary Defense and Strategic Communications Satellite (SGDC)
Applications	• Secure communications for the benefit of the government, military and civilian sectors. • Access for populations living in remote areas to broadband Internet in the country (National Broadband Program).
Strategic Objectives	• Develop communication capacity by satellites autonomously. • Promote digital inclusion. • Increase the technological base of the national industry and its innovation and competitiveness capacity in domestic and foreign markets.
Users	• Telebras • Ministry of Defense
Planned Launches	• SGDC-1: 2014 • SGDC-2: 2019
Participating Companies	• Visiona
International Partnerships	

Features

Satellite in the orbital position of 75 ° W with 15 years lifetime:

- Strategic and defense telecommunications in X-band, with regional coverage (Brazil), Latin America and the Atlantic Ocean, using five transponders.

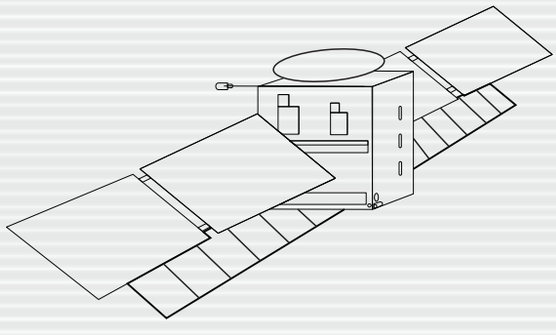
- Telecommunications in Ka-band to support the National Broadband Program, with nationwide coverage, including 200 nautical miles of the



Project	Synthetic Aperture Radar Satellite (SAR)
Applications	• Generate Earth images from using radar sensor, for use in applications related to the environment, agriculture, defense and other purposes.
Strategic Objectives	• Increase the country's capacity and autonomy for Earth observation. • Increase the technological base of the national industry and its innovation and competitiveness capacity in domestic and foreign markets. • Encourage innovation and the development of satellites with radar system.
Users	• INPE • Government bodies and agencies focused on environmental protection and natural resources management. • Ministry of Defense • Image processing companies.
Planned Launches	• 2020
Participating Companies	
International Partnerships	

Features

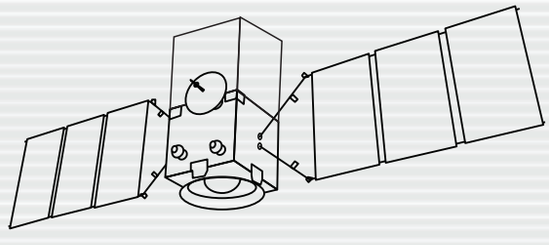
Medium resolution remote sensing satellite equipped with imager with synthetic aperture radar, operating in multiple modes, with resolutions ranging from 5 to 30 meters.

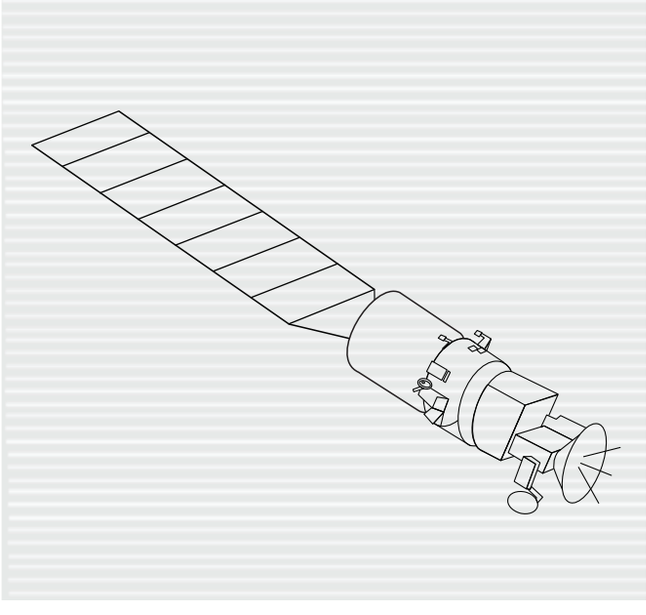


Project	SABIA-Mar Satellite (Brazil - Argentina Cooperation)
Applications	• Monitor the color and temperature of sea water and ocean environment, for increased knowledge of ocean flora, fauna, topography and other features of that environment.
Strategic Objectives	• Increase the autonomous capacity of the two countries to acquire data and information on the southern Atlantic Ocean. • Increase the technological base of the national industry and its innovation and competitiveness capacity in domestic and foreign markets.
Users	• INPE • Government bodies and agencies, Brazilian and Argentine, focused on environmental protection and natural resource management. • Tourism and aquaculture industries.
Planned Launches	• 2019
Participating Companies	
International Partnerships	• Argentina

Features

Remote sensing satellite, equipped with optical payloads operating in the visible and infrared spectrum with resolutions ranging from 200 meters to 2,200 km.

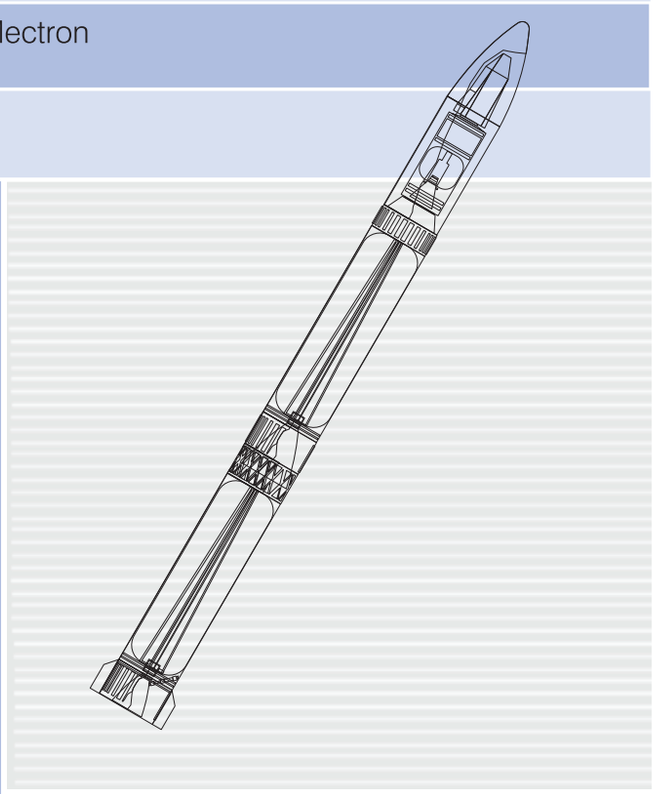


Project	Brazilian Meteorological Satellite GEOMET-1
Applications	• Generate images of Earth's atmosphere from space to generate data required for weather forecasting systems.
Strategic Objectives	• Enable the country to obtain meteorological data and information from the national territory and other regions of the Earth, autonomously. • Increase the technological base of the national industry and its innovation and competitiveness capacity in domestic and foreign markets.
Users	• INPE • Ministry of Agriculture • Ministry of National Integration • Ministry of Defense
Planned Launches	• 2018
Participating Companies	
International Partnerships	
Features	

Project	Microsatellite Launch Vehicle (VLM)
Applications	• Launching of microsatellite weigthing up to 150 kg.
Strategic Objectives	• Ensure the country's capacity to access space with its own means and resources. • Explore niche market for commercial launches of microsatellites. • Increase the technological base of the national industry and its innovation and competitiveness capacity in domestic and foreign markets.
Users	• AEB • DLR (Germany) • Microsatellite manufacturers • Companies that provide satellite launch services.
Planned Launches	• 2015
Participating Companies	• Cenic, Avibrás, Mectron
International Partnerships	• Germany

Features

Solid propellant, three-stage rocket, with capacity to launch up to 150 kg in low earth orbit of up to 300 km.



Project	Satellite Launch Vehicle (VLS-1)
Applications	• Development and qualification of onboard equipment and ground systems required for future national launchers.
Strategic Objectives	• Ensure the country's capacity to access space with its own means and resources. • Increase the technological base of the national industry and its innovation and competitiveness capacity in domestic and foreign markets.
Users	• IAE • Companies that develop and manufacture launch vehicles and subsystems.
Planned Launches	• Technology test flight XVT-01 VSISNAV: 2013 • Technology test flight XVT-02: 2014 • VLS-1 V04 flight: 2015
Participating Companies	• Combrae, Confab, Fautec, Metalpaulista, Alutrate, Mectron, Cenic, Alltec, Platflow, Villares-Metals, Alcoa
International Partnerships	• Russia

Features

The XVT-01 technology flight, also known as VSISNAV, has only the first two stages active.

The XVT-02 technology flight is a complete vehicle (four active stages) with a technology payload.

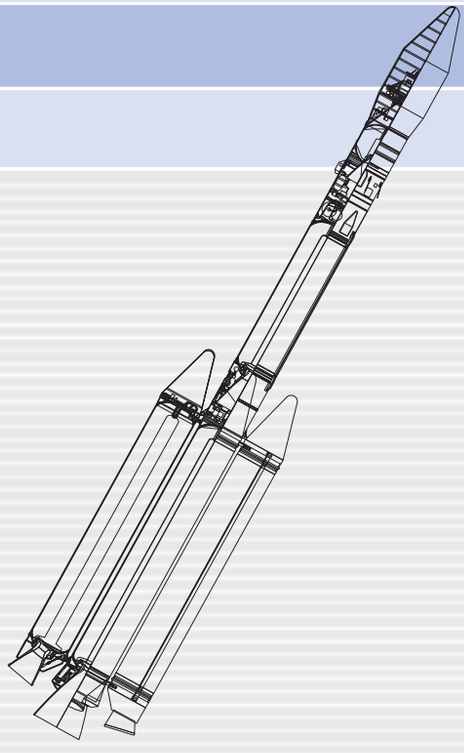
The VLS-1 V04 will be a complete vehicle that will launch a payload still to be defined, of up to 250 kg, in orbits up to 700 km.

Project	Satellite Launch Vehicle (VLS-ALFA)
Applications	• Launching satellites weigthing between 200 kg and 500 kg.
Strategic Objectives	• Enable the country to access space with its own means and resources. • Increase the technological base of the national industry and its innovation and competitiveness capacity in domestic and foreign markets.
Users	• Manufacturers of satellites weigthing up to 500 kg for LEO orbit. • Companies that provider satellite launch services.
Planned Launches	• 2018
Participating Companies	
International Partnerships	

Features

The Alfa launch vehicle comprises the lower part of VLS-I1 as first (four S43 solid rocket motors) and second (one S43 solid rocket motor) stages and a liquid propulsion engine with 7.5 tons of thrust (L75) as upper stage.

The vehicle's performance, superior to that of VLS-1, will allow the launch of satellites weigthing up to 500 kg in equatorial orbit of 750 km, or 200 kg in polar orbit.

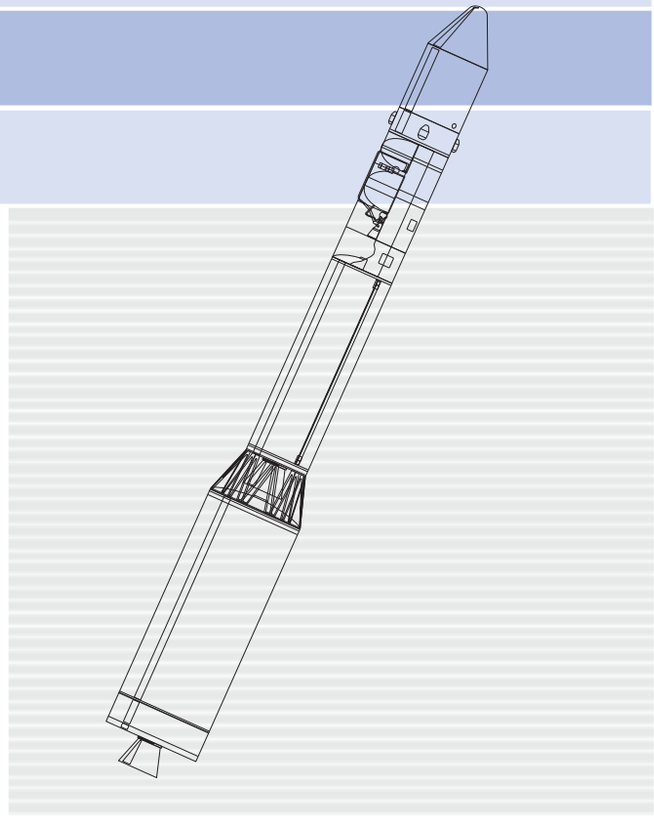


Projeto	Satellite Launch Vehicle (VLS-BETA)
Applications	• Launching satellites weigthing up to 800 kg.
Strategic Objectives	• Enable the country to access space with its own means and resources. • Increase the technological base of the national industry and its innovation and competitiveness capacity in domestic and foreign markets.
Users	• Manufacturers of satellites weigthing up to 800 kg intended for LEO orbits. • Companies that provide satellite launch services.
Planned Launches	• 2020
Participating Companies	
International Partnerships	

Features

The Beta launch vehicle has a solid propellant booster as a first stage (P40), a second stage with four L75 liquid engine and a single L75 as upper stage.

The VLS-Beta vehicle's performance allows lauching satellites weigthing up to 800 kg in equatorial orbit of 800 km.



Project	Cyclone-4 Launch Vehicle
Applications	• Launching of satellites weighting between 1.600 kg and 5.600 kg.
Strategic Objectives	• Introduce the country into the world market for commercial launches of satellites. • Enable the country to access space with its own means and resources. • Increase the technological base of the national industry and its innovation and competitiveness capacity in domestic and foreign markets.
Users	• Binational Company Alcântara Cyclone Space (ACS) • AEB • Satellite manufacturers and operators.
Planned Launches	• 2014
Participating Companies	• Binational Company Alcântara Cyclone Space (ACS) • Ukrainian Companies Yuzhnoye and Yuzhmash
International Partnerships	• Ukraine
Features Liquid propellant launcher with planned capacity to launch up to 1,600 kg in geostationary orbit or 5300 kg in low equatorial orbit.	

Project	VSB-30
Applications	• Launch of scientific and technological experiments for operation in short-duration microgravity.
Strategic Objectives	• Explore the niche market of suborbital launch services for experiments in microgravity environments. • Enable the country to access space with its own means and resources. • Increase the technological base of the national industry and its innovation and competitiveness capacity in domestic and foreign markets.
Users	• AEB (microgravity experiments program) • European Space Agency (ESA) • National and international academic community. • Companies that provide space launch services.
Planned Launches	• One launch a year
Participating Companies	• Fautec, Utec, Usifran, Metaltécnica, Cenic, Orbital, Metalcard, Autec, Plastflow
International Partnerships	• Germany

Features

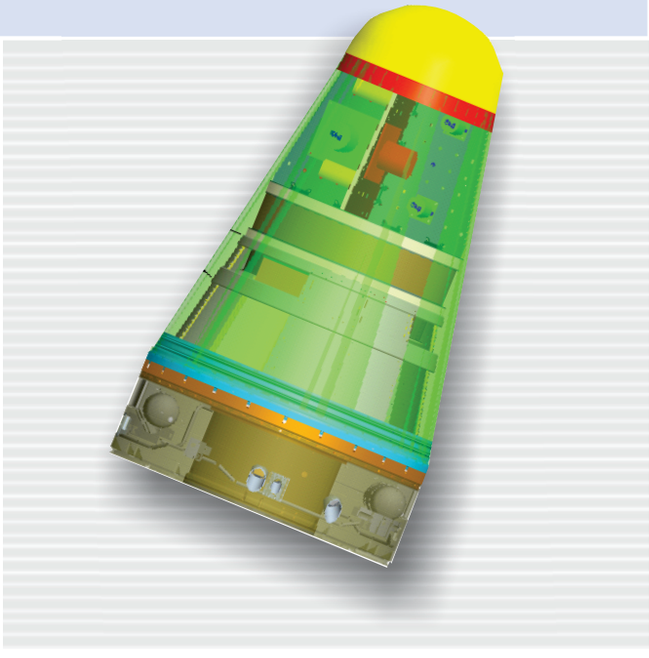
Bi-stage sounding rocket aimed at transporting scientific and technology payloads weighing up to 400 kg for experiments at an altitude of 250 km.

Used to conduct scientific and technology experiments in microgravity.

Project	Atmospheric Reentry Satellite (SARA)
Applications	• Orbital and suborbital platform with reentry capabiliity for microgravity experiments.
Strategic Objectives	• Enable the country to access space with its own means and resources. • Explore the commercial market for services of launch and recovery of experiments in microgravity. • Master the technology of atmospheric reentry.
Users	• AEB (microgravity experiments program) • European Space Agency (ESA) • National and international academic community. • Companies that provide space launch services.
Planned Launches	• Suborbital flight: 2013 • Orbital flight: 2015
Participating Companies	• Cenic
International Partnerships	

Features

An orbital platform of 300 kg to perform scientific and technology experiments in microgravity at low Earth orbit (LEO) of 300 km.



List of Acronyms

AAB
Brazilian Aerospace Association

ACS
Alcântara Cyclone Space

AEB
Brazilian Space Agency

AIAB
Aerospace Industries Association of Brazil

ANA
National Water Agency

ATS
Sectorial Technological Agenda

CBERS
China-Brazil Earth Resources Satellite

CEA
Alcântara Space Complex

CLA
Alcântara Launch Center

CLBI
Barreira do Inferno Launch Center

COMAer
Air Force Command

DCTA
Department of Aerospace Science and Technology

END
National Defense Strategy

GEOMET
Geostationary Meteorological Satellite

IAE
Institute of Aeronautics and Space

INPE
National Institute for Space Research

MCTI
Ministry for Science, Technology and Innovation

MD
Ministry of Defense

PMM
Multi-Mission Platform

PNBL
National Broadband Program

PNAE
National Program of Space Activities

PNDAE
National Policy for the Development of Space Activities

QUALIESPAÇO
Program to Support Standardization and Quality Activities in the Space Area

SAE
Secretary of Strategic Affairs of the Presidency of the Republic

SAR
Earth Observation Synthetic Aperture Radar Satellite

SARA
Atmospheric Reentry Satellite

SGDC
Geostationary Defense and Strategic Communications Satellite

SINACESPAÇO
National System of Conformity Assessment in the Space Area

SINDAE
National System for the Development of Space Activities

S&T
Science and Technology

VLM
Microsatellite Launch Vehicle

VLS
Satellite Launch Vehicle