

NATIONAL TECHNOLOGY INITIATIVE IN SPACE

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Abstract

The establishment of the Turkish Space Agency in 2018 and the task of preparing the National Space Program assigned to it enabled our country to create a national strategy in the field of space that would include all institutions and organizations in the sector. National Space Program which has been studied in this context and which has been introduced by the President on February 9, 2021, our country's space strategy covering the next 10 years was presented to the public. The National Space Program is a comprehensive project prepared for the coordinated and integrated execution of our country's vision, strategies, goals and projects in the field of space policies in order to utilize the current potential in our country, taking into account the developments in the world. With the National Space Program Strategy Document published on 24.05.2022 (Official Gazette dated), TUA has been tasked with providing coordination and accelerating the current studies in order to advance the space studies in our country within the scope of the determined road map. The National Space Program Strategy Document is an important strategy covering the years 2022-2030, which will constitute a roadmap for space studies by the Turkish Space Agency Presidency and will accelerate existing studies and advance these studies. Within the scope of this strategy, it is aimed to ensure that the space industry ecosystem in country becomes technological and commercial, competitive, dynamic, sustainable, innovative and entrepreneurial, taking into account the benefits that the industry will bring to the country. Studies for this purpose continue within the scope of the strategies and principles determined as a result of multi-stakeholder participants and collective studies under the coordination of the Turkish Space Agency.

Ensuring independence in access and use of space, strengthening the space ecosystem, enriching the field of usage of space for the benefit of society, getting an ever increasing share from the global space market, developing international cooperation opportunities that support the peaceful use of space; realizing the space strategy in an efficient, safe and sustainable way is of great importance for our country.

Keywords

Turkish Space Agency, National Space Program, National Technology Initiative in Space, Turkish Astronaut, Moon Mission

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Overview of National Space Program

Space technologies come to the fore as a leading force in the development of countries in every field, and its importance is recognized more and more every day. While space technologies, which have become indispensable in almost every field of life, from transportation to agriculture, from urban planning to security, from communication to mining continue to move rapidly in the world, our country has not remained indifferent to these technologies. The torch that burned with the launch of Türksat 1B, our first communication satellite, into space on August 11, 1994 and placement into orbit, has inflamed even more today as we have reached the capacity to produce satellites using domestic and national resources. Space studies accelerated and gained a new dimension in the light of the establishment of the Turkish Space Agency and the National Space Program announced by our President, and the goals created by consensus within the scope of this program. Cooperation protocols have been signed with relevant institutions, organizations and universities, and coordinated works have started with these targets as the focus point.

It is necessary to summarize briefly the goals in the National Space Program and the contributions of these goals in the coming years.

1. Moon Research Program

The Moon mission within the scope of the National Space Program has been named as the Moon Research Program (AYAP). The Moon Program is defined under two phases, planned as a hard landing on the Moon in 2023 (AYAP-1) which marks the 100th anniversary of the Republic of Türkiye, and a soft landing in 2028 (AYAP-2).

In AYAP-1, it is aimed that the spacecraft, shall brought to Earth orbit with international cooperation, shall be placed into lunar transfer orbit with a domestic and national hybrid propulsion system and shall make a hard landing on the Moon surface. The spacecraft, which will first be placed into an Earth orbit, will then be injected into the lunar transfer orbit with the firings to be made in orbit and will begin its journey to the Moon. When the spacecraft approaches the gravitational field of Moon, it will be placed in orbit with re-firings, and after various measurement studies and image acquisition to be made here, maneuvers to make a hard landing on the Moon's surface will be prosecuted

Within the scope of the program, it is aimed that our country will be among the few countries that can develop a spacecraft capable of reaching the Moon from the Earth and conduct research on the Moon. In addition, it is aimed to develop a indigineous and national spacecraft engine, to reach a level that can compete with countries having similar technologies in the world, and to provide space flight heritage to the national systems and subsystems planned to be used in the program.

With the second phase of the program, AYAP-2, it is planned to launch the spacecraft into Earth orbit with a indigeneous and national launch vehicle, and then a make soft landing on the Moon's surface. With this stage of the program, our country will gain the ability to deliver a spacecraft to the Moon with national propulsion systems.

It was not possible for our country to remain indifferent to the increasing interest towards the space sector in the world, and space programs and targets were created by using domestic and national technologies in an accelerated way. With the Moon Research Program (AYAP) created in this context, our country will be among the countries leading scientific studies in the field of space, and will also gain experience and competence in the

field of deep space studies. In addition, with the aforementioned Moon program, it is aimed to increase the interest and awareness in space in our country and to create competent human resources in the field of space.

2. Regional Navigation and Timing System (BKZS)

Satellite Based Positioning Systems are systems with global or regional coverage that allow mobile or static position determination on land, air and sea using the signals they broadcast over satellites. Satellite Based Positioning Systems were firstly developed by the USA and Russia in order to meet the positioning needs of air and naval forces during the Cold War period. These systems, which are used for military purposes and do not have continuity of coverage, allow low-accuracy positioning with LEO (Low Earth Orbit) satellites. Over time, these systems have been replaced by modern satellite systems such as GPS and GLONASS, which provide global coverage continuity with MEO (Middle Earth Orbit) satellites. These systems have been opened for civilian use over time and their utilization areas have increased rapidly. Due to the fact the global systems are quite costly, systems such as NavIC and QZSS which provide regional coverage with GEO (Geo-stationary Orbit) and IGSO (Inclined Geosynchronous Orbit) satellites, have started to be established in recent years.

In order to understand the competencies that the Regional Navigation and Timing System will bring to our country, it is needed to look at the areas in which the Global Satellite Based Positioning Systems (GNSS) are used. GNSS is used effectively in banking, transportation, agriculture, search and rescue, logistics, military applications and many more.

Civilian citizens use navigation in transportation. GNSS is also utilised in areas where positioning is of critical importance, such as aviation and maritime. Sowing and mowing are done with autonomous machines in agriculture. These machines are able to determine their position precisely with GNSS signals. GNSS signals are used to find location in search and rescue activities. GNSS is used for tracking vehicles in logistics. In some parts of the world, insurance companies have started to determine prices, by based on the GNSS receivers placed in the vehicles based on the average speed of the vehicle and the route data. GNSS signals are critical in most military applications.

As seen, GNSS is used both in applications that facilitate human life and in different areas of critical importance. If GNSS signals are turned off over our country, we may encounter catastrophic results. The establishment of the Regional Navigation and Timing System will make us one of the few countries that has independence in terms of positioning, navigation and timing signals acquisition. Within the scope of this work, human resource will grow, know-how will be gained, and our infrastructure will develop. The commercial navigation service and the atomic clock, which is the heart of the Regional Navigation and Timing System, will contribute to the national economy.

3. Observation and Tracking of Space Objects from Ground

Throughout history, one of the greatest goals of humanity has been to reach space. There has been a space race between the United States and the Soviet Union, especially since the 1950s. The first successful attempt was made by the Soviet Union (USSR), and the space race started as a result of the launch of the Sputnik-1 satellite into space on October 4, 1957. Countries that participated in this race have sent artificial satellites designed for different purposes, especially communication, security and scientific researches, to the Earth orbits. However, with the increasing number of satellites and the completion of their mission, a different problem has come to the fore. Currently, there are tens of thousands of

artificial objects (satellites and rocket parts) placed into orbit, launched by different countries.

The rapid increase in the number of space debris and satellites and the fact that most of them move completely uncontrolled in the orbit of the earth have started to pose a great risk for active satellites. For this reason, many countries have established satellite surveillance and monitoring centers. In our country, which has active satellites in space, the establishment of a center where observation and tracking of space objects from the earth is important in terms of economical, political and security reasons. Observation and Tracking of Space Objects from Ground was included in the National Space Program. In this context, thanks to the infrastructure to be established and the methods to be developed, monitoring active satellites, obtaining changes in their current orbital parameters, and cataloging the unidentified space debris by obtaining their orbital parameters will be an important gain for our country, which is advancing rapidly in the field of space. In addition, it is aimed to train equipped manpower to establish the necessary scientific and technological infrastructure, to monitor space objects, to obtain space situation awareness and to ensure sustainability. Thanks to the systems and infrastructures to be developed, the security of our assets in space will be ensured by the orbit detection of satellites, space debris and other celestial objects that may threaten the safety of satellites.

4. Unification of Satellite Production Under A Single Framework and Indigenous Satellite Development Programme

When the global size of the satellite sector is analyzed, it is seen that the supply level is increasing every year. It is obvious that in order for our country to have a say in this sector and to reduce foreign dependency, it is critical to gather satellite production under one roof and to produce indigenous satellites.

In Türkiye, there are such institutions and organizations that have the infrastructure and capability related to satellite production. However, each of these institutions works within their own strategy and technology roadmap. These studies may not always give the desired efficiency in terms of financial resources and human management. With this program, it is aimed to ensure that satellite production activities are carried out with the highest efficiency and effectiveness by analyzing the developments correctly in satellite technologies in the world.

In order to maximize the efficiency of satellite production activities and to avoid duplicate studies within the sector in our country:

- Consolidate core skills that are relevant to satellite technologies and incorporate them in Center,
- Perform effective resource management in line with the requirements in a centralized manner,
- Minimizing the foreign dependency in the satellite sector, are being targeted.

When the satellites that Türkiye has by this time are examined, BİLSAT, the first observation and remote sensing satellite in the Turkish satellite sector, was produced with the contributions of Türkiye. In addition, Rasat remote sensing and GÖKTÜRK-2 reconnaissance satellites and İTÜpSAT1, TÜRKSAT-3USAT, BeEagleSat, HAVELSAT and UBAKUSAT satellites were manufactured by our country. It is seeing that,

GÖKTÜRK-1 remote sensing and TÜRKSAT 1B, 1C, 2A, 3A, 4A, 4B, 5A and 5B communication satellites are produced by France, Italy and Japan.

Many of the well-established satellite production companies have undergone changes such as name changes, mergers, restructuring or partnerships; new and ambitious companies have stepped into the market. Some of the new companies aim to create large satellite constellations around the Earth with many satellites they manufacture. Considering this situation, the Turkish Space Agency aims to increase the competitiveness of our country with the world by supporting and standardizing the micro-satellite projects currently ongoing by universities and companies.

By force of this program, which aims to gather the satellite production activities carried out under different companies in Türkiye under a single company, determining Türkiye's current satellite production capabilities and gathering this capacity under one roof in the most efficient way will cause reaching a level that can have a corner on the world satellite market.

5. Access to Space and Spaceport

The Mission of "Access to Space and Spaceport" within the scope of the National Space Program; aims to produce Türkiye's sustainable, innovative technologies comprised, cost-effective commercial launch vehicle and to establish the Spaceport in order to independently realize the spacecraft and satellite launching needs of Türkiye, to build a commercially sustainable system by using the opportunities of international cooperation, and to provide international service.

The Access to Space and Spaceport Feasibility Study was initiated under the coordination of the Turkish Space Agency (TUA) to study the future launch vehicle technologies, payloads and trajectories and launch sites with industry representative institutions and organizations. In this regard, as a first phase, The Access to Space and Spaceport Analysis Study has been completed.

In the Access to Space and Spaceport Analysis Study, 4 sub-working groups (Mission Payload Sub-Working Group, Launch Vehicle Sub-Working Group, Launch Vehicle and Components Technologies Sub-Working Group, Spaceport Sub-Working Group) were formed. In the light of the data obtained and the information compiled during the study, the current situation in the world for the 4 determined titles has been revealed. After the analyzes carried out, some predictions have been made about the characteristics of the launch vehicle, such as the class of the launch vehicle, the payload capacity, the trajectory to which it will send the payload, the number of stages, the fuel type of the stages, which are required for the sustainable, cost-effective and competitive realization of The Access to Space and Spaceport Mission within the scope of the National Space Program.

In the light of the findings and predictions of the previous analysis study, The Access to Space and Spaceport Feasibility Study is going to be started soon. The technical and administrative work will be initiated for the production of the launch vehicle and the establishment of the Spaceport.

6. Turkish Astronaut and Science Mission

Turkish Astronaut and Science Mission has been started for the purposes of sending a Turkish citizen into space and carrying out scientific experiments. Within the scope of the Turkish Astronaut and Science Mission (TABM), a Turkish citizen will be sent to the

International Space Station (ISS) to perform scientific missions after the necessary training. In this regard, the experiments of the science mission to be carried out on the ISS will be determined and the relevant materials and equipment will be prepared. In addition, it is aimed to send a domestically produced, experimental/scientific Cube Satellite (CubeSat) into orbit.

Within the scope of the Turkish Astronaut and Science Mission to be carried out under the coordination of TUA; the selection and training of a Turkish astronaut, determination of the mission and design of space experiments and the experiments to be carried out on the ISS will be of significant importance in terms of studies to be performed in the micro-gravity.

By providing Turkish citizens' access to space with international cooperation and encouraging their participation in scientific studies to be carried out in space;

- To provide opportunities for Turkish scientists about space studies,
- To increase Türkiye's visibility in space,
- To raise awareness about space in the national public,
- To encourage young generations to work in the field of space,
- To increase interest in science and technology is aimed.

Apart from these, astronaut candidates and astronauts who will be sent to the ISS; will have the opportunity to share the experiences gained in astronaut training, launch operations, docking and leaving the ISS, entering the atmosphere and during his stay on the ISS to young people and students for many years.

Turkish Astronaut and Science Mission which is aimed to be realized in the 100th anniversary of the establishment of the Republic of Türkiye will be noted in history and it will provide inspiration to young generations in the field of space studies in addition to scientific researches.

7. Development of the Space Industry Ecosystem

In the recent past, space, which is a strategic sector, has started to become a sector not only financially supported by states but also evolved into a commercial sector in which private companies also take initiatives. It is evaluated that the competence to be acquired in this sector, which increases its strategic importance day by day while commercializing, it will contribute to the domestic and national development of especially critical technologies, and increase the soft power of the country together with the contribution of the goods and services to be provided abroad to the economy.

8. Space Technologies Development Region

Technology development regions have become increasingly popular in the recent years, as the benefits they bring have been recognized. Within the scope of the target, it is aimed to increase the cooperation and harmony between companies by bringing together the companies working in the field by a technology development regions to be established in our country in the field of space and aeronautics, to improve the R&D and innovation capability of our country in the field, and to create an ecosystem that creates added value in a sustainable way. In addition, the realization of this goal constitutes an important step to be taken towards achieving the "Development of the Space Industry Ecosystem" target.

Studies in line with the strategies, principles and methods determined within the scope of the National Space Program for the purpose continue within the body of the Turkish Space Agency.

9. Space Awareness and Development of Human Resources

It is of great importance that the employees who will take part in space applications have received training in related fields and have competence in areas that require advanced technology. In addition, mistakes made in projects for space applications are generally not compensated and the cost is high. For these reasons, the role of the personnel serving in the sector has a critical importance. Obtaining the necessary human resources for the sector is a time-consuming process by its nature. In this respect, it is important to support the education received through the guidance of the relevant persons and internships while the trainees go through an appropriate academic education process. It is evaluated that it is important for people who have completed their education life to gain the most benefit within the scope of the education they receive while entering their professional life, and to bring their knowledge in their relevant fields to business life by being assigned to projects suitable for them.

In addition, it is considered that the activities and programs to be carried out to increase space awareness will contribute to directing the young population to space, increasing their curiosity in this area and providing the public's support for the activities to be done in this area.

Within the scope of this goal, the Turkish Space Agency aims to obtain the necessary human resources and to raise awareness on the importance of space studies. Studies are carried out within the scope of the strategies and principles determined for this purpose.

10. Space Weather

Although Türkiye buys and uses Near-Ground Space (YYU) technologies, it does not have a historical, systematic, scientific and technological background in this field. With the announcement of the National Space Program, Türkiye's space activities began to gain momentum. It is essential to understand space weather thoroughly in order to efficiently use the technologies that we will benefit from on the ground and in space, and to protect the investments made from the effects of space weather.

Space weather encompasses all impacts between the Solar System and the Near Earth environment (about 150 million km). Some of these effects are Solar flares, coronal mass ejection (CME), energetic particles from the Sun (Solar Energetic Particles), Solar Winds, Ionospheric Disturbances and Geomagnetic Storms. Unloading of electric power plants, corrosion of pipelines, additional currents in communication wires, effects on ecosystem and climate change, static electricity charging of satellites can be given as examples of effect of space weather. One of the most striking examples of these effects was a 9-hour power outage in Quebec, Canada, in 1989, as a result of a geomagnetic storm created by a coronal mass ejection, resulting in millions of dollars of damage.

In order to investigate the effects of Space Weather and to better understand and take the necessary precautions, the Turkish Space Agency has started studies to establish the Space Weather Application Center (UHUM). Equipment such as radio telescope and ionosonde will be used in this center.

The purpose of UHUM will not only be to conduct research, but also to raise awareness of the effects of space weather, to warn in advance of these effects, to create risk management for these effects, and to design activities related to preliminary plans and programs that will reduce possible harm. In order to minimize possible space weather effects, efforts are made to create warning, nowcast, forecast and space weather risk management with the data to be obtained.

UHUM has been designed to be compatible with its foreign counterparts, and in order to start the project studies and carry out its activities effectively in the first stage, the “Space Weather Application Center Unit” was established under the umbrella of the TUA Organization, based on the legislative authority given to TUA in the Presidential Decree on the Turkish Space Agency. This Center will be identified as one of the regional alert centers and will be connected to the relevant European and international centers. This Center will be the first national center on space weather.

Conclusion

The establishment of the Turkish Space Agency, the announcement of the National Space Program, the communication and remote sensing satellite studies that are currently ongoing with domestic and national facilities show the point our country has reached in the field of space.

The realization of the targets set in the National Space Program will not only cause acceleration and development in the field of space, but also contribute significantly to the development of employment and capabilities in the relevant sectors. It is foreseen that the studies and technologies developed in this context will enable our country to be among the countries that have a say in the field of space technologies.

Turkish Space Agency, in line with the main goals of National Space Program, will contribute to successful progress of “National Technology Initiative”, and our country's goal of becoming an “effective and strong” country by realizing vision, strategy, goals and projects in the field of space.

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Mr. Yıldırım started his undergraduate education at Istanbul Technical University Aeronautical Engineering Department and graduated from Berlin Technical University Department of Aeronautics and Astronautics. He completed his master's degree in the field of Aviation and Space Sciences at Berlin Technical University. He gave airline management lectures at Kadir Has University. He worked in various airline companies in project consultancy and management positions. Yıldırım, who served as the Chairman of the Board of Directors and General Director of the State Airports Authority, has been most recently the General Director of Aeronautics and Space Technologies. With the Appointment Decision dated 07.08.2019 no. 261, Mr. Serdar Hüseyin Yıldırım was appointed as the first president of Turkish Space Agency.