# NATIONAL TECHNOLOGY INITIATIVES IN SATELLITE TECHNOLOGIES

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**Abstract**

There has been a need for communication since the existence of mankind. The man has tried to solve this problem in various ways, such as, by using cave paintings, smoke, fire, or trained pigeons. The printing press was the main tool for communication for some years and then the telegraphs were the first tools of wired communication. The telegraph was introduced in 1838 and the telephone in 1876. Image sending was used for the first time in 1926. In the 1970s, wireless communications became eminent. Today, mobile telephone and satellite communications become the usual means of communication for daily life. For satellite communications, Türkiye initially chose to rent satellite channels from foreign satellite companies. But this was neither strategical nor economical, so Turkish authorities decided to establish Türkiye's own National Satellite Systems. In order to achieve this goal, Türkiye has started satellite studies since the 1990s. The first Turkish own satellite TÜRKSAT-1A crashed into the ocean due to a malfunction on the third floor of the rocket. On 11 August 1994, TÜRKSAT-1B communication satellite was launched into space. TÜRKSAT-1B, TÜRKSAT-1C, TÜRKSAT-2A, TÜRKSAT-3A, TÜRKSAT-4A, TÜRKSAT-4B, TÜRKSAT-5A, TÜRKSAT-5B were successfully launched and for the time being TÜRKSAT-3A, TÜRKSAT-4A, TÜRKSAT-4B, TÜRKSAT-5A and TÜRKSAT-5B have been continuing their duties. TÜRKSAT-6A, which was produced with domestic resources, is planned to be launched in 2023. It is planned to complete the test activities of the TÜRKSAT-6A satellite in the 2nd quarter of 2023 and to make it ready for transportation and to launch it in the 3rd quarter. It is aimed to use the experience, infrastructure and flight equipment gained within the scope of TÜRKSAT-6A in our future satellite programs, thereby reducing foreign dependency in the satellite sector. BİLSAT and RASAT, are low orbit satellites developed by TÜBİTAK UZAY. GÖKTÜRK-1 and GÖKTÜRK-2, which are also low orbit satellites, can carry high resolution Electro-Optic (E/O) cameras. Within the scope of the GÖKTÜRK-1 Project, the Satellite Assembly, Integration and Test Center (USET) was established. This center was a critical infrastructure for the domestic production of communication satellites. The above-mentioned developments inevitably inspired institutions-organizations and young engineers in Türkiye and increased momentum for satellite development activities in LEO orbit. The TÜRKSAT Model Satellite Competition also pioneered the national mobilization in this field. Afterwards, this competition was included in TEKNOFEST. TÜRKSAT organizes the 7th Model Satellite Competition. TÜRKSAT aims to train human resources in the field of satellite and space technologies. While fulfilling these objectives, TÜRKSAT will increase the quality of human resources and provide a certification service in the field of satellite and space science. This will be beneficial for our friendly countries. Digitally produced training materials will be presented to the relevant international units so that a sustainable system will be established. This system will minimize the negative human factor and will provide universally accepted certificates to be produced. This system will be able to be used by the universities and students may have certificates during their education.

***Keywords***
*Satellite Communication, National Technology Initiatives, Türkiye's Satellite Technology*

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## Introduction

Technological innovation in satellite production technology and the decrease in launch costs have increased the number of satellites sent into space. Developments in satellite and launch technologies, innovations in-ground systems and a variety of services provided by satellites, encourages anyone in the sector to follow up on new developments.

### Türkiye's GEO Communication Satellites

Türkiye's dealing with the satellites began in the 1990s (Özalp, 2009; Zaman, 2020). On December 21, 1990, an agreement was signed with the French Aerospatiale company for the construction of Communication Satellites. On January 24, 1994, TÜRKSAT-1A (it fell into the ocean due to a malfunction in the third floor of the rocket), on August 11, 1994, the TÜRKSAT-1B communication satellite was launched into space into 42° East orbit, TÜRKSAT-1C satellite into 31° East orbit on July 10, 1996, TÜRKSAT-2A satellite was sent to 42° East orbit on 11 January 2001 and TÜRKSAT-3A satellite was sent to 42° East orbit on 13 June 2008 with the Ariane 5 ECA launcher from Guyana Space Center in Kourou.

An agreement was made with Japanese Mitsubishi Electric for the construction of Communication Satellites, Türksat-4A satellite was placed in 42° East orbit on 14 February 2014, TÜRKSAT 4B satellite was placed in 50° East orbit on 16 October 2015 from Kazakhstan Baikonur cosmodrome with Proton M launcher. An agreement was made with the French Airbus company to build Communication Satellites and Türksat-5A satellite was launched into 31° East orbit on January 8, 2021, Türksat-5B satellite was launched into 42° East orbit on December 19, 2021, with Falcon 9 rocket at Cape Canaveral Base in Florida, USA.

TÜRKSAT-6A satellite, developed locally in our country, will be placed in 42° East orbit between the last quarter of 2022 and the first quarter of 2023. Türkiye has four orbits to use for its communication satellites. These orbits are 8.5°, 31°, 42° and 50° east. TÜRKSAT A.Ş. actively provides fast and reliable communication with TÜRKSAT 3A, 4A, 4B and 5A satellites. C-band, X-band, Ku-band and Ka-band are used in satellite communication systems. In Figure 1, active and obsolete communication satellites of TÜRKSAT in orbit are shown. Türkiye's satellite road map is also shown in figure 1. Table 1 shows the technical specifications of the TÜRKSAT-6A communication satellite, which was developed locally in Türkiye.

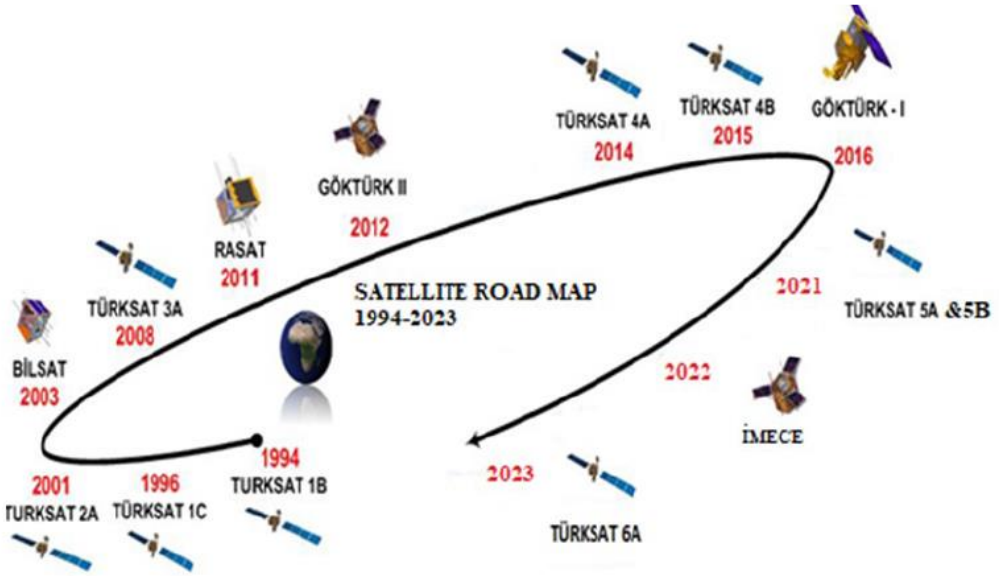


***Figure 1.*** *Satellite roadmap of Türkiye*

***Table 1.*** *Technical Specifications of TÜRKSAT 6A Communication Satellite*

| Features | |
|---|---|
| **Orbit** | $42^0$ east geostationary |
| **Useful load** | 20 Ku-Band Transmitters (140W output)<br>20 Ku-Band Transmitters (120W output) |
| **Service Life** | 15+1 years |
| **Reliability** | 80% (end of 15th year) |
| **Launch Compatibility** | Ariane V<br>Proton M<br>SpaceX |
| **Weight** | 1800 kg dry<br>4200kg wet |
| **Maximum Power Generation** | 12 kW<br>8kW (end of life) |

## Türkiye's LEO Communication Satellites.

While TÜRKSAT's activities in the field of communication satellites continue, the first studies in the LEO orbit, which are called near-ground orbit, started with TÜBİTAK.

Two tasks of the BİLSAT satellite, named ÇOBAN and GEZGİN, were designed, manufactured and placed on the satellite by TÜBİTAK UZAY. This satellite was fully manufactured by domestic industry. The BİLSAT project was carried out to initiate, develop and support small satellite technologies in Türkiye. A ground station was established in partnership with SSTL (Surrey Satellite Technology Limited) to create the necessary infrastructure for the design and production of small satellites domestically. Türkiye's first remote sensing satellite, BİLSAT, was launched from Russia's Plesetsk Ramp into space with the Cosmos-3 launch vehicle. BİLSAT, which is designed to have a duty life of 5 years, completed its mission at an altitude of 686 km, in a synchronous orbit with the Sun (Yılmaz et al., 2020; Tübitak Uzay).

RASAT Research Satellite is the second remote sensing satellite owned by Türkiye and TÜBİTAK UZAY after BİLSAT. RASAT has a high-resolution optical imaging system and new modules designed and developed by Turkish engineers. It is the first earth observation satellite designed and manufactured in Türkiye. It was launched into space on 17 August 2011 by Dnepr launch vehicle, from the Yasny Launch Base in the Orenburg region of Russia's Kazakhstan border. The satellite can receive images with 7.5 meters black and white and 15 meters multi-band resolution from anywhere in the world without any restrictions.

RASAT operates in a simultaneous orbit to the Sun at an altitude of approximately 700 kilometers. It can be used for identifying oil spills in the seas, monitoring urban development, land use in agriculture, monitoring water levels in dams, city planning and mapping. RASAT's design life is 3 years, but it still continues its mission successfully today.

GÖKTÜRK-2, Türkiye's first high-resolution earth observation satellite, was designed by Turkish engineers and placed in a solar synchronous orbit with an altitude of approximately 700 km. It was launched into space on 18 December 2012 by a LongMarch 2D rocket, from Jiuquan Launch Center in China. GÖKTÜRK-2 has left behind its 10th year in orbit, despite its design life was 5 years. GÖKTÜRK-2 satellite, which has a high level of reliability in international standards, meets important needs in the fields of defense, environment, urbanism, agriculture and forestry while providing satellite images to public institutions in the fields of disaster monitoring, city planning, agricultural land monitoring, forest fires and intelligence. GÖKTÜRK-2 satellite has 2.5-meter resolution and produced in high percentage in Türkiye. The GÖKTÜRK-2 project is aimed to develop technology, expert manpower and infrastructure for space and satellite systems and to meet the observation and research needs of public institutions and organizations. These targets have been almost achieved today. Expert manpower to take part in future satellite projects has been trained. Infrastructure and capabilities have been acquired for analysis, design, assembly, integration and testing activities of satellite production technology.

GÖKTÜRK-1 is an Earth Observation and Reconnaissance Satellite, which carries a high-resolution Electro-Optic (E/O) camera. It was successfully launched into space from French Guiana with the Vega rocket (TUSAŞ, 2021) on 5 December 2016. GÖKTÜRK-1 project was carried out by The Undersecretariat for Defence Industries (SSB), with the responsibility of Telespazio-Italy (TPZ) and Thales Alenia Space-France (TAS-F) companies. GÖKTÜRK-1 Satellite System has a resolution below 1 meter; it allows obtaining high-resolution images for military intelligence purposes from any region in the world without geographical restrictions; It provides images that are required for many civil application areas. The Satellite Assembly, Integration and Test (USET) Center was established within the scope of the GÖKTÜRK-1 Project. This center is critical for the development of technology for space and satellite systems and to raise expert manpower for the domestic production of future observation and communication satellites. Environmental and functional tests of the GÖKTÜRK-1 Satellite were carried out at the USET Center with the participation of Turkish engineers and it was shipped to the launch site from this center. The satellite network has a design life of 7 years and it successfully carries out its mission in the sun-synchronous orbit at an altitude of approximately 681 km.

## TÜRKSAT and the International Telecommunication Union (ITU)

The Union, of which Türkiye is one of the founders, is the specialized agency of the United Nations responsible for information and communication technologies (ITU, 2022a). The Union makes frequency allocation in the 8.3 kHz-3000 GHz range. It has also the following objectives. In order to prevent harmful interference between radio stations of different countries, to allocate bands and frequencies in the radio frequency spectrum, to keep radio frequency records, to keep records of the characteristics of satellites in geo-synchronous orbit and other orbits, to coordinate efforts to prevent harmful interference between radio stations of different countries to improve the use made of the radio-frequency spectrum for radio communication services and of the geostationary-satellite and other satellite orbits.

The provisions that must be followed by all ITU member states are regulated in the ITU Radio Regulation (RR) and Rules of Procedure (RoP) Implementation Rules. Developing technology, new services, or changes in existing services require capacity and spectrum demand and necessitates updating existing regulations. Radio Regulations are being reviewed and updated at World Radio Communication Conference (WRC) which is held by ITU every four years. At these conferences, ITU regulates all kinds of frequency planning and spectrum management regarding the services offered in the radio frequency spectrum.

**Frequency Coordination and Frequency and Orbit Usage Rights:** In order for a communication satellite to be put into operation by any country or operator, the satellite network is compatible with the technical characteristics such as the orbit, frequency band, coverage area and service type of this satellite must be registered at the ITU. The registration procedure for the satellite network consists of the application, coordination, commissioning, notification and registration to The Master International Frequency Register MIFR (ITU, 2022b).

**Satellite Network Filling:** The submission of a satellite network filing is made by sending the technical details of the satellite network prepared with the software developed by ITU by using parameters determined in line with technological developments, satellite planning and strategic goals to ITU. The submitted satellite network filing is published in the CR/C (CoodinationRequest) section of the BR-IFIC (International Frequency Information Circular) published every 2 two weeks by ITU. ITU examines the satellite network filing application for compliance with RR provisions. If the satellite network submitted is foundfavourableITU will assign the official date of receipt of the satellite network as the date of protection application is approved and the application date of the satellite network in question is recorded. If it is not found appropriate, the filing applicant is returned to the notifying applicant administration in order to eliminate the nonconformity.

**Coordination**: Prior to start of execution date of the applied satellite network, the effect on other countries satellite networks and on the applicants whose coordination process is ongoing are examined. ITU publish all these cases in the same CR/C according to RR procedures. If some satellite networks object to the new applicant network due to interference, ITU coordinates them to find a solution for both network owners. Both sides may communicate through mutual correspondence or frequency coordination meetings organized by ITU. If an agreement was reached for some point, then these are recorded in the minutes. Unless otherwise stated, the satellite networks must be operated according to the agreement conditions.

**Bringing into Use**: For the related satellite network to be used by registering with MIFR, ITU regulations must be fulfilled within the regulatory time limit. Coordination activities must be completed within 7 years from the official date of receipt of the satellite network by ITU for unplanned band frequencies and 8 years for planned band frequencies. A satellite must be operated in accordance with the parameters submitted in the satellite network filing in the geostationary-satellite orbit at the notified orbital position for a continuous period of 90 days. Otherwise, the satellite network in question is canceled by ITU.

**Notification and Registration to MIFR:** In order to obtain the right to use a satellite network, necessary coordination work is completed with all administrations for which approval is required. Reference parameters are updated on agreed values and the notification information is sent to ITU (ITU, 2022c). After the technical and regulatory controls are carried out by ITU, the relevant allocations are registered in the MIFR if it is determined that the coordination has been completed and the satellite network has been brought into use. Thus, satellite networks registered in MIFR receive protection and international recognition. Satellite networks registered in MIFR continue to be valid as long as they are operated in accordance with the parameters submitted in the satellite network filing in the geostationary-satellite orbit. If the satellite, operated in the registered satellite network, completes its lifetime or leaves orbit for any reason, a suspension notice must be sent to the ITU for the relevant network. The date on which the recorded assignments are brought back into use shall not be later than three years from the date of suspension. Otherwise, the registered satellite networks will be canceled.

## Knowledge and Experiences Gained with TÜRKSAT-6A

Undoubtedly, the biggest gain of the studies is for the production of the Türksat-6A satellite and Türkiye continues on this path with firm steps. The ground segment software of this satellite is being developed in Türkiye and design and system engineering is also completed by Turkish engineers.

TÜRKSAT A.Ş. with its qualified human resources and its experience in the sector has provided important engineering contributions to the development of the TÜRKSAT-6A satellite. Within the scope of the TÜRKSAT-6A project; TÜRKSAT A.Ş. and the Ministry of Transport and infrastructure are the client institutions, TÜBİTAK-UZAY is the project manager, Turkish Aerospace Industries (TAI), ASELSAN A.S. and Ctech companies are project executive organizations. It is planned to build 3 different models: Thermal Structural Qualification Model (IYYM), Engineering Model (MM) and Flight Model (UM). The Thermal Structural Qualification Model and Engineering Models are designed to verify the design and determine the necessary design improvements for the Flight Model to be launched.

- Project design activities started in December 2014.
- Thermal Structural Qualification Model (IYYM) integration was completed in April 2018. Test activities such as system level Thermal Vacuum Test, Acoustic Vibration Test, Center of Mass Measurements, Static Load Test were carried out.
- In March 2019, engineering model integration activities were completed. After the satellite MM integration was completed, the MM Test Preparation Review (THGG) Meeting was held on April 15, 2021.

- In the current situation, Basic Functional Tests, MM Thermal Vacuum Test (IVT), Acoustic and Vibration test activities have been carried out. Preparations for the Compact Antenna Test (CATR) continue at the USET center located in TAI.
- As of May 2022, integration of the Flight Model was completed and the first functional tests of the Flight Model were started. After the completion of these tests, environmental tests (thermal vacuum, vibration, acoustic and antenna verification) will be performed.

The equipments of 29 satellites were developed 100% domestically, by the project manager and executive organizations within the scope of the project. After the production and test procedures, satellite equipments have been successfully integrated into the satellite. When the satellite starts working in its orbit, these equipments will be part of history.

TÜRKSAT A.Ş. is responsible for the Launcher determination and service procurement. After a careful evaluation and negotiation process, the "TÜRKSAT-6A satellite launch service contract" was signed with Space X (Falcon-9) on July 5, 2021. This contract is the first contract, signed directly between TÜRKSAT A.Ş. and the launch company instead of the satellite manufacturer. In addition, the TÜRKSAT 6A satellite will be the communication satellite to be launched with the Falcon 9 rocket belonging to the Space X Company, after the Türksat-5A and Türksat-5B satellites.

Activities and transactions within the scope of the Launcher service procurement are carried out by TÜRKSAT A.Ş with relevant experts. It is planned to complete the whole production of the TÜRKSAT-6A satellite in the 2nd quarter of 2023 and make it ready for transportation and launch it in the 3rd quarter. We will use the experience, infrastructure and flight equipment gained within the scope of TÜRKSAT-6A in our future satellite programs. In this way, it is aimed to reduce foreign dependency in the satellite sector. The above-mentioned developments have inspired young engineers and institutions in the country. The LEO satellite development has gained momentum. The TÜRKSAT Model Satellite Competition also pioneered the national mobilization in this area, as a result, this competition was included in TEKNOFEST

**TÜRKSAT's Education Support Services**

TÜRKSAT, Türkiye's leading technology institution, will organize the 7th Model Satellite Competition. TÜRKSAT aims to train human resources in the field of satellite and space technologies.

In the USA, NASA organizes a satellite design competition, named CANSAT, to train human resources and to encourage universities to study satellites across the USA. A similar competition was organized domestically by TÜRKSAT in 2015. TÜRKSAT Model Satellite Competition was included in the Teknofest Organization in 2018 with the contract signed between the Turkish Technology Team (T3 Foundation) Foundation and TÜRKSAT.

TÜRKSAT Model Satellite Competition was planned to reflect the satellite/space project on a small scale. It covers all aspects of a satellite/space project, from design to production and post-mission process. We provide competitors the opportunity to experience the process from the design of a space system to its commissioning. We aim that the students gain real space project experience with low budgets. This becomes important if we consider the high cost of participation in competitions held abroad. This will encourage the students studying at the university to transform theoretical knowledge into practice, promote

interdisciplinary work, strengthen the sharing of experience and contribute to the manpower multiplier of the sector.

Many competitors, who were included in the competition processes within the scope of the national technology initiatives, declared their companies will work in the space and aviation sector. One of these teams, the Grizu-263 team from the Zonguldak Bülent Ecevit University, designed a pocket satellite and placed it in low orbit in January 2022. TÜRKSAT cooperated with the successful teams in the rocket competitions and became the subcontractors by supporting their launch processes costs. TÜRKSAT also helped The ITU Pars Rocket group, in 2020. Pars Rocket team is currently working on a rocket hybrid engine under the name of Novar A.Ş. TÜRKSAT cooperated with Pamukkale University Caspian Rocket Team, which took part as a subcontractor in 2021 and 2022 and continues to work under Alya Aerospace. Caspian rocket team supported the rocket processes as the subcontractor of Azercosmos company and made its first export at the Teknofest event held in Azerbaijan.

TÜRKSAT supported some teams that have achieved outstanding success in the CANSAT competitions held in the USA. Among the top 20 teams that showed success in the CANSAT processes, the Turkish teams had the highest number among all of the international participants.

The process, which started in 2016, with 3 teams and 18 people, turned into a competition that reached approximately 700 people with 111 applications in 2022. After completing the Qualification Review (QR) phase, in 2021, 20 finalist teams are selected. The Model Satellites of these teams were launched with rockets designed specifically for the competition.

The TÜRKSAT Model Satellite competition statistics from 2016 until 2022 are given in Figure 2 below.

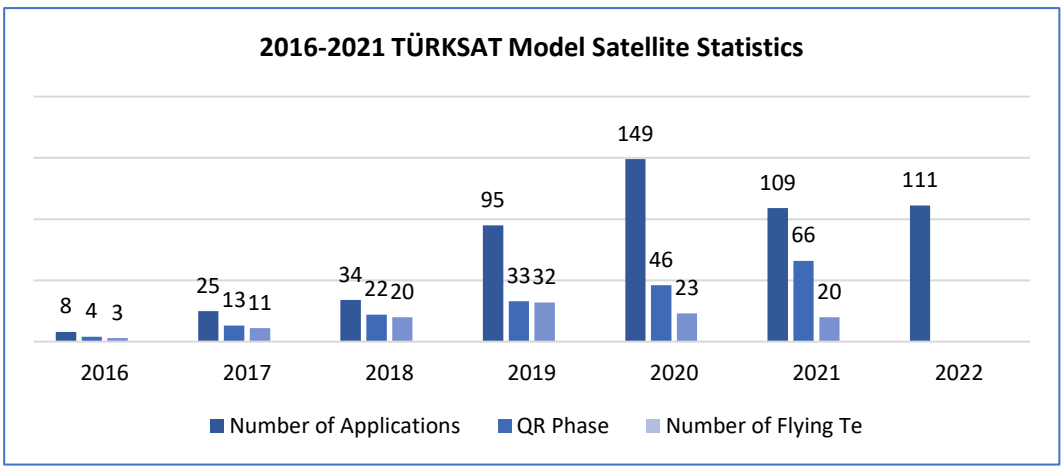


***Figure 2.*** *TÜRKSAT model satellite competition statistics*

**TÜRKSAT 2022 Model Satellite Competition rules and Finalist Team Tasks**

If a team passes the first 5 stages (out of 7 stages), the team must transfer Telemetry data and image data received from 8 sensors (temperature, pressure, auto-gyro, camera.etc) into ground station and must visualize the transferred data in graphical format at the command-and-control center. In the competition held this year, beyond the existing 34 requirements the following tasks are required.

- **Altitude Stabilization:** After leaving the carrier, the payload will remain suspended for 10 seconds with the auto gyro & accelerometer control system at a range of 200 (+/- 50) m. It will stabilize its altitude.
- **Inter-Systems Communication Network (SAHA):** One-way data transfer module is integrated on the carrier. After leaving the carrier the pressure and location information of the payload will be sent to the ground station. Teams will display the altitude change between the carrier and the payload and the connection status between each other on the ground station.
- **Original Task 1:** One of the problems is to increase the visibility of the payload in the atmosphere after the payload leaves the carrier. The team must validate any solutions they have proposed for this problem.
- **Original Task 2:** Each team must perform a design approach inspired by real satellite or space missions, or any original mission where scientific data can be obtained and processed. The designed satellite must be within the specified size and weight limits,
- **Asynchronous Video Transfer (Bonus Mission):** After the model satellite leaves the rocket, the 300 KB video transferred from the ground station to the model satellite will be sent back to another ground station computer using a different frequency.

Thus, the working principle of the communication satellite will be fully realized. After completing these tasks, it is expected that new ideas and innovations will emerge from the TÜRKSAT Model Satellite Competition. By organizing this competition, TÜRKSAT trains the competing teams, forms the competition requirements and the performance of the eligibility analysis, carries out the technical evaluation of the reports created by the teams throughout the competition process and follows up the organization during the 8-months of the competition process.

**Results and Evaluation**

As explained above, Türkiye's journey on satellite systems is quite comprehensive in terms of both gaining orbital rights and satellite and rocket studies. This acceleration is expected to contribute to the development of more National Technologies for our country. The space objects belonging to Türkiye in space as of June 2022 are summarized in Table 2 below.

As can be seen in Table 2, Türkiye has begun to reap the fruits of its efforts for decades, both with the increase of social awareness and with new generation initiatives in order to have a say in space. Now, technology institutions and university laboratories can reach space, as well as large government-sponsored investments.

The number of people working in the fields of space, aviation and defense industry, which is a large area of developing technology, has been increasing over the years. The increase

in the number of young employees interested in the subject in Türkiye is the best example of this.

With the gradual decrease in launcher costs and the increase of various companies that enable the launch of satellites of different masses into space, it will undoubtedly increase the transportation to space. While fulfilling these objectives, TÜRKSAT will increase the quality of human resources and provide a certification service in the field of satellite and space science. This will be beneficial for our friendly countries. Digitally produced training materials will be presented to the relevant international units so that a sustainable system will be established. This system will minimize the negative human factor and will provide universally accepted certificates to be produced. This system will be able to be used by the universities and students may have certificates during their education.

***Table 2.*** *Space Objects Belonging to Türkiye*

| Satellite Name | Debris | Decay | Active | Orbit |
|---|---|---|---|---|
| BİLSAT 1 | * | | | LEO |
| BEEAGLESAT | | 27.04.2019 | | LEO |
| GOKTURK 1A | | | * | LEO |
| GOKTURK 2 | | | * | LEO |
| HAVELSAT | | 28.02.2019 | | LEO |
| ITUPSAT 1 | | | * | LEO |
| TÜRKSAT 1B | * | | | GEO |
| TÜRKSAT 1C | * | | | GEO |
| TÜRKSAT 2A | * | | | GEO |
| RASAT | | | * | LEO |
| TÜRKSAT 3A | | | * | GEO |
| TÜRKSAT 4A | | | * | GEO |
| TÜRKSAT 4B | | | * | GEO |
| TÜRKSAT 5A | | | * | GEO |
| TURKSAT-3USAT | * | | | LEO |
| UBAKUSAT | | 11.06.2020 | | LEO |
| GRIZU 263A | | | * | LEO |
| TÜRKSAT 5B | | | * | GEO |

## References

International TelecommunicationUnion. (01.06.2022a). *Collection of the Basic Texts of the International TelecommunicationUnion (Edition of 2019)*. https://www.itu.int/pub/S-CONF-PLEN-2019 (Erişim Tarihi: 15.06.2022)

International TelecommunicationUnion. (01.06.2022b). *World Radiocommunication Conference*. https://www.itu.int/en/ITU-R/conferences/wrc/Pages/default.aspx (Erişim Tarihi: 15.06.2022)

International TelecommunicationUnion. (2022c, Haziran 01). *RadioRegulations (Edition of 2020)*. https://www.itu.int/pub/R-REG-RR-2020 (Erişim Tarihi: 15.06.2022)

Özalp, T. (2009). Space as a strategic vision for Turkey and its people. *Space Policy*, 25(4), ss. 224-235.

TUSAŞ – Türk Havacılık ve Uzay Sanayii A.Ş. https://www.tusas.com/urunler/uzay (Erişim tarihi: 29.05.2022)

TÜBİTAK (29.05.2022). Uydu Projeleri. https://uzay.tubitak.gov.tr/tr/uydu-uzay/uydu-projeleri (Erişim Tarihi: 29.05.2022)

Yılmaz, Ü.C. Sakaci, C. Koçak, M.D. Er, T. & Toktamış, B. (2020). De-orbitand Deactivation of a GEO

Satellite: TURKSAT-2A. *2020 AAS/AIAA Astro-dynamics Specialist Virtual Conference*, 9-12 August 2020, 1877-1883

Zaman, N. (2020). Paratic. https://paratic.com/iletisim-araclari-nelerdir-kronolojik-siralama/ (Erişim tarihi: 18.03.2020)

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He was born in 1969 in Çaykara, Trabzon, Türkiye. He completed his undergraduate studies in Mathematics, at Istanbul Technical University, his master's degree in Computer Engineering from Istanbul Technical University and his doctorate in Applied Mathematics from Yıldız Technical University. He started his academic life as a Research Assistant in 1994. He started his career as an Assistant Professor in the Department of Computer Engineering in 2000, served as the Deputy Head of the Department in the same department and earned the title of Associate Professor in 2012. Yüksek, who received the title of professor in 2017, specializes in software, database design, mathematical modeling, artificial intelligence, computer graphics, education management and civil aviation management. He served as the Head of Training at Turkish Airlines between 2013-2018, in May 2019, he became Deputy General Manager of the General Directorate of Civil Aviation. He became the Chairman of the TÜRKSAT Board of Directors in March 2019. In January 2021, he was appointed as the Deputy General Manager of the General Directorate of Civil Aviation. Yüksek is the author of many national and international academic articles. He is married and has three daughters.