Hungary’s Space Strategy

Content

INTRODUCTION

Supportive public opinion on space economy and space industry[1] is an enabling factor, "back wind" of the developments. At the dawn of the space era, the main goal for researchers and relating industry was to create carriers which were bigger and could travel further. The public opinion was, understandably, dominated by the spectacular scientific and technical solutions associated with them. With the extraordinary expansion of information technology, space economy has created application possibilities and synergies that require a far broader interpretation of what space industry entails. Nevertheless, public opinion still identifies the opportunities offered by space economy with rocket technology using enormous material resources, space station operations and reaching other planets, while space industry sets far more material and intellectual resources in motion, and opens up new, directly accessible growth paths to a much wider economic sector than the results appearing in the media.[2]

Hungarian space research and space activities go back to a history of 75 years, since the famous Lunar Radar experiment of the *Hungarian scientist, Zoltán Bay*. The abilities of Hungarian research entities, academic institutions, and even economic actors also stand out on a global scale.

After the regime change, statutes of subsequent Hungarian governments regularly include the coordination of this policy area as a task to manage. According to the currently valid statute ((143. §), the minister who leads the Ministry of Foreign Affairs and Trade (MFAT) *"in the framework of his responsibility for space research, performs tasks related to international agreements on space research, furthermore space research and space policy programme-preparation and harmonisation tasks arising from European integration; and based on his authorisation, represents the Government in international organisations, and elaborates the main directions and programmes of space research"*.

It can be stated that Hungary has strong traditions and real, marketable competencies in the field of space activities.

The Hungarian space industry and space research capacities have gained increased relevance in the past decades. According to all reports, the space sector is one of the most dynamically developing and crisis-resilient areas of the world economy. Moreover, positions in the market and on the global political stage have not solidified, they are constantly changing. The expansion of space application areas and the continuous development of applied technologies foresee the increase and acceleration of competition. Any possible exclusion from the market competition may require later major expenditures for maintaining the position achieved in the sector, or may result in higher entry barriers for new entrants.

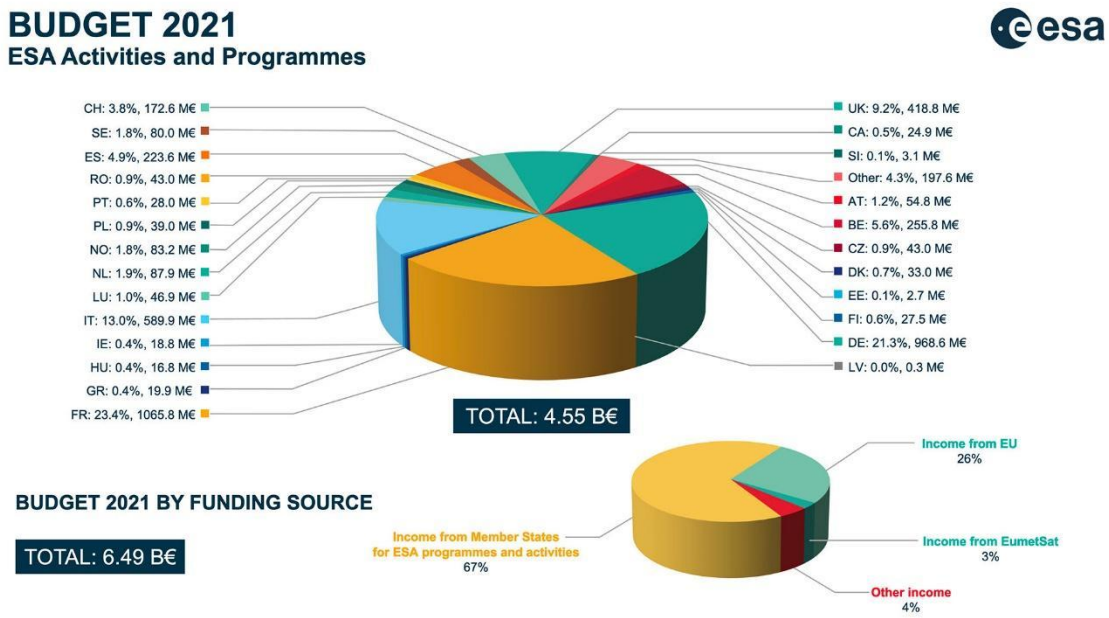
The need to respond to the challenges of the Hungarian space research and space activities is justified not only by global processes, though a timely realisation of those is a substantial motivation for

[1] Space sector, that is space economy encompasses all primary research, experimental, educational, organisational, manufacturing, service, space object production, information technology, communication activities, infrastructure development and accompanying management, international relations, etc. tasks that is related to the use of outer space. According to the definition of European Investment Bank (2019), space sector is an economic sector, which production and service profiles, economic interests, management solutions and relations are connected with the space economy and space sector.

[2] This disproportion is well illustrated by the number of online appearances and their content-related ratio in the electronic media. As an example, space research in Hungarian was written in the google search, and 1.4 million results came up, while searching the expressions of space economy, space sector or space industry, 50 thousand results appeared on the internet on 19 January 2021.

Hungary to act. Another important factor is the ambitions of the regional competitors. Nowadays, not only the great powers that are traditionally able to utilise the potential of space, and not only the developed countries with strong economies increase the governmental investment to space sector, but the regional partners, as well *(Chart 1)*.

Chart 1: European Space Agency's budget in 2021 in respect of countries financially contributing to the programmes



Source: ESA, 2021

In the last decades, a comprehensive, strategic document on space research and space activities was not yet available in Hungary. As a consequence, until recently, the sector did not have a long-term funding. Previously, no documentation was available which in one would introduce the Hungarian space sector, introduce it's goals to the decision-makers, and most importantly identify and express Hungary's national interests.

It is an international tendency and expectation for all participating countries in space activities to possess a national Space Strategy, and a Space Programme based on it. Now, the European Space Agency (ESA), of which Hungary is a full member, formulates the approval and demonstration of a Space Strategy as a precondition for accession. ESA is currently a multilateral organisation with 22 members, and the majority of the member states have created their national documents (Space Strategies), among them Hungary's regional partners (Austria, Czech Republic, Poland and Romania).

It is important to emphasize that the European Union (EU) is also in the possession of a Space Strategy and an own Space Programme, which is growing extremely dynamically both in terms of ambition and budget. ESA and the EU approve the documents setting common strategic objectives every year when convening the joint ministerial council *(Resolution and Council Conclusions)*. The most recent joint document was signed by the ministers responsible for space of both EU and ESA member states in November 2020 *(Orientations on the European contribution in establishing key principles for the global space economy)*. Although the document is not a strategy on it's own, it can be referred to as a strategic document. The Council Conclusion specifies the main objectives of Europe's space activities for the period ahead.

It follows that

Hungary should have a Space Strategy in accordance with the country's possibilities, capabilities, geopolitical goals, and economic development directions, which

gives a realistic view of the current situation in Hungary,

recognises breakout opportunities and identifies directions for development.

In its structure and content, the documents follows the 38/2012 (March 12) governmental decree Article 18 – §35(1) about the governmental strategic direction which define the requirements for achieving a medium-term vision of the policy strategies. According to this, a nearly 250-page situational exploration, analysis and evaluation document, as a summary of hundreds of pages on diagnostic exploration, has been compiled to serve as the foundation of Hungary's Space Strategy. The vision and objectives were set by a SWOT-analysis (Strengths, Weaknesses, Opportunities, Threats), and based on it, the measures and interventions to achieve these objectives have been formulated. [3]

The decree pre-determines the personal, material, professional, financial and organisational conditions, and risks of necessary interventions, furthermore the basic principles and system of implementation and evaluation. As the harmonisation of domestic sectoral operative programmes is currently underway, the planning of resource allocation is also still in progress.

The Strategy is supplemented by more detailed elaboration of a number of measures, which serve the achievement of the objectives as high priority, and therefore should be implemented in the short term. It does not contain detailed planning of necessary interventions needed for the measures, including realisation deadlines, concrete responsible persons and the size of resources. These are tasks dedicated to the policy programme.

[3] It is an important aspect that lower-class goals should appear alongside higher-class goals, as well as the explanation of interventions, that is the principle of "higher-level goals always include lower-level goals" should prevail. Length of the goals: long-term vision is for 15-20 years, medium-term goals are for 10-15 years, while short-term interventions are for 5-7 years, adapting to the EU budgetary periods.

EXECUTIVE SUMMARY

Participation in space activities used to be limited to nations with the ability to sustain high-cost investments. Nevertheless, the Hungarian space sector has been involved in international collaborations and programmes for decades, utilising its marketable competencies in the field of research and production. The explosive development of technology, furthermore the spread of the New Space phenomenon made it possible for smaller nations to get involved in space activities.

Strengthening the knowledge triangle (education, research and innovation) with clear research programmes can improve the market attitude, skills and motivation of research institutions, while providing innovation potential for the domestic economy, with a high rate of return. Thanks to its knock-on effects, this process highly contributes to increasing efficiency and competitiveness of the economy, while stimulating the spread of innovative technologies and interdisciplinary knowledge in other economic sectors, as well.

The vision and scope set out in Hungary's Space Strategy are consistent with the economic development and employment protection intentions of the Ministry of Foreign Affairs and Trade (MFAT) and the Government, while contributing to a higher quality of life in society. The Strategy sets targets for 2030, and addresses the most urgent interventions in its short-term action plan.

Vision of the Strategy:

Hungary is an important actor in the realm of international space activities, utilising the positive social and economic effects of the space sector.

The three strategic targets focus more on effective utilisation of the available capacities and abilities by developing international partnerships and educational-scientific conditions.

Strategic targets:

1. Utilising the potential in the space sector to stimulate innovation and sustainable growth in the national economy as a whole.
2. Strengthening Hungary's international role, broadening its network, and creating organisational framework for coordination.
3. For the prosperity of space sector, the development of knowledge-based social and economic conditions and infrastructural background is essential.

The scope of the Strategy insists on 9 specific targets and 32 measures. Specific targets:

1.1 Strengthening multiplicative effect of the Hungarian space sector.
1.2 Building targeted competencies in the segments with high market potential.
1.3 Integration development of the space sector.
1.4 Supporting sustainable development of the economy in the long term.
2.1 Supporting Hungarian space activities through central coordination, institutional background and complex national communication.
2.2 Strengthening Hungary's diplomatic positions, increasing abilities to enforce its interests.
2.3 Fostering our role in international programmes.
3.1 Long-term foundation and acceleration of human resources development.
3.2 Improving the operational and infrastructural conditions of the institutional system.

To implement the main priorities in a complex and contextual way, short-term measures have been selected based on the goals set. As a first step, by a detailed elaboration of these measures it is possible to eliminate the backlogs in the most urgent areas of domestic space activities (lack of experts, isolation of knowledge triangle of education, research and innovation, shortcomings in organisation-operation and support, an international representation of interests, exposure to global processes, space industrial catching up).

The implementation of the Strategy is also served by the establishment of an organisation that deals with domestic communication and coordination tasks, and multifariously supports the actors in the sector. At the same time, it is responsible for international relations and information transmission, and among its activities, preparation of relevant documents, regular revision, creation of an internal database on the actors in the sector and a monitoring system are included. In order to ensure the international validation of Hungarian actors, it has to take a significant role in the establishment of domestic accreditation systems and operational frameworks.

The crisis-resistance of the space industry is fundamentally determined by the state's involvement, this fact is supported by the data of the Hungarian Chamber of Commerce and Industry (HCCI) survey conducted in Hungary in 2020 and 2021. According to the survey, space activities will increase with the support of state resources in the next 10 years (in addition to state financing, the companies' own assets and the European Union funding will play an important role). In addition to the state's and the government's active involvement, through the implementation and development of the strategies, as well as with procurement and finance, the national space sector can be placed on a long and predictable development path. This also supports the sustainable development of the national economy, and preserves the options for intervention in order to achieve the state's strategic goals.

Based on Hungary's Space Strategy and the short-term action plan, approximately HUF 30-35 billion is the additional estimated amount of resource needed for the Hungarian space industry in the coming five years, beyond international commitments (e.g. ESA membership fee and bilateral projects). In the post-covid-19 crisis period, a slow run-up is suggested in terms of state expenditures. For the first period (5 years), the annual breakdown of the projected HUF 30-35 billion state expenditure is as follows *(Table 1)*:

Table 1: Annual breakdown of the estimated state expenditures beyond international commitments

YEAR	NATIONAL EXPENDITURE (billion HUF/year)
2021	3-4
2022	5-6
2023	8-9
2024	7-8
2025	7-8
Total	**30-35**

Source: University of Public Service, Economic Implications Research Team, 2021

In the post-covid-19 crisis period, based on the economic growth and budget positions, in case of increasing GDP, a higher rate of support is possible. It should be pointed out that the subsidy would not increase mechanically, but by taking into account the absorption capacity of space companies. In the case of projects assigned to strategic goals, depending on their specific technical content, acceptance of separate government decisions on budgetary resources is required.

This incentive and business development is driven by the state's role which is complementary to the ESA budget – in addition to adequate corporate commitment, and enhancement of education, research, testing, quality assurance, logistic, management environment, international relations, as well as a supportive shift in attitudes – will lead to a substantial shift towards the goals set (for the first phase: 2021-2025). Until 2030, in the second phase the estimated need for funding is HUF 10-15 billion, which is "sustainable" in the long-term, and more moderate than in the first phase. As a payoff of this, assuming the demands created by global development, and also the continuity of development, the capacity of the space industry could be doubled compared to today's level. By the end of the decade – according to the technical projection – at an unchanged price as in 2020, it could almost triple, and reach HUF 80 billion in revenue. The use of a larger rate of private assets, concessions, credits, subsidies and tax incentives, EU resources, as well as a capital supplement can be also assumed.

In 3-4-year perspective, by 2025 at the latest, a realistic goal is to double the number of companies, and strengthen some of the existing companies in terms of higher performance and market position. Quantified, based on the estimated size of the sector, this would mean 60-70 companies within the developing space industry ecosystem. It follows that doubling the number of employees in the space sector by 2025 is a realistic accompanying target that includes an increase in the number of researchers and experts, as well.

Based on the action directions set in order to achieve the developmental goals of the space sector, there is a realistic chance that Hungary will take a more active role in shaping the European space activities, building on the change in approach and results attained since 2018.

I. ANTECEDENTS

Summary of examination

International findings

Today, many nations in the world run space activities. In the early stage of space competition, the United States of America and the Soviet Union far excelled in terms of their space capabilities and sources for space activities.

Nowadays, the situation has changed a lot. The USA and after the Soviet Union's breakup, Russia remained dominant in international space activities, but it cannot be said that these two countries still hold full hegemony. It is a completely new development that privately owned companies have also joined the space competition, and launched a considerable number of activities in space, especially the US-based Space X, Virgin Galactic Holding and Axiom Space, which has recently started to cooperate closely with NASA.

Russia, even in the years after the Soviet Union's breakup, maintained its space capabilities, and operated the MIR space station until 2001. Based on the experiences gained there, and also with broad international cooperation, the International Space Station (ISS) could be established, which is still operating. After the shutdown of the American space shuttle programme, Russia has provided the US astronauts' lift to the ISS, and while the USA is once again able to send humans into space on its own since 2020, they still keep valid contracts for transporting astronauts on Russian spacecrafts. It is important to mention that ESA's astronauts have also travelled by Russian spacecrafts over the past period, and the infrastructure capable of serving Russian-technology spacecrafts has also been built in ESA's space module.

In addition to the traditional two "great space powers", the European Space Agency has considerable capabilities, as well, and now it is one of the world's most significant organisations carrying out space activities, ensuring the possibility for its members to fulfil roles in complex missions that they would not be able to execute on their own.

In 2021 the two most determining nations of European space activities, France and Germany, provide 44.7% of ESA's overall budget. By comparison, Hungary provides 0.4%, Czech Republic, Poland and Romania 0.9-0.9%, the four Central-European member countries altogether contribute with 3.1% to the ESA's budget[4].

France excels in its space capabilities, as the French ArianeGroup, in which Airbus is an owner, produces rockets of Arianespace in its majority holding, also in the country. Besides, ESA's space centre is located in French territory, in French Guiana.

China is the third state that has an extremely considerable space programme, and has been able to send a human to space on its own. China also plays a role in the most important field of current space competition, as it is involved in a number of research projects on the Moon. China is less open to international cooperation, but this is increasingly changing. Since 2014, the country has been consciously fostering the capitalisation of its space economy. After the USA, China became the second

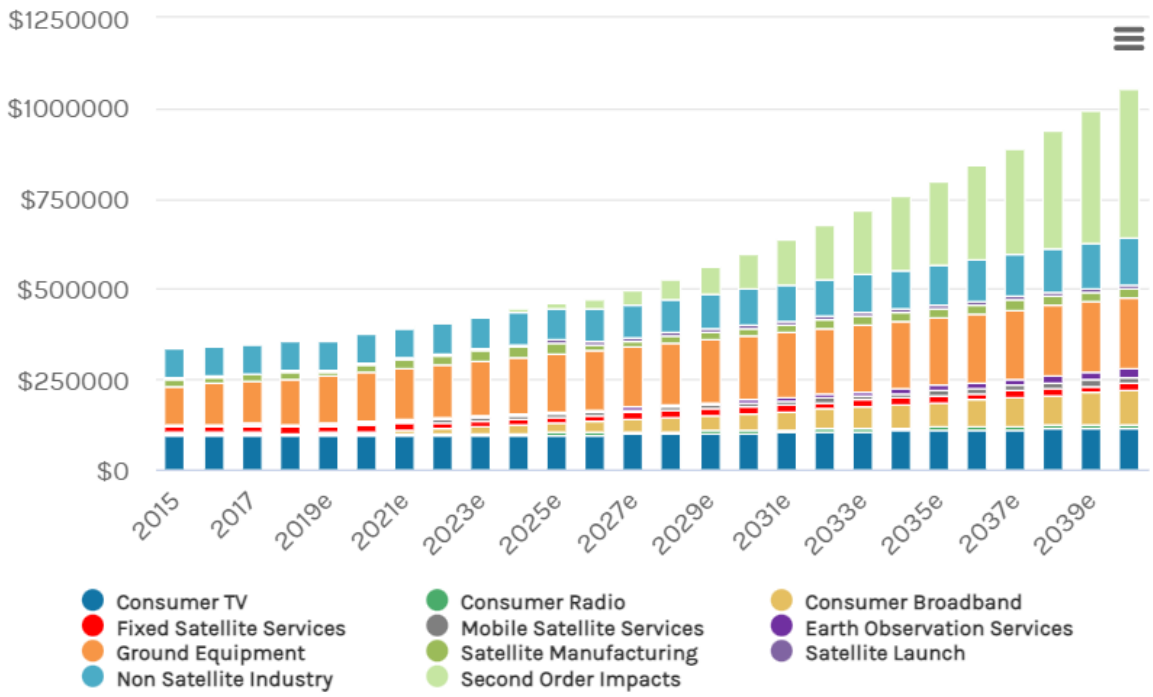
[4] ESA's budget, 2021

largest investor in the space sector, with a significant state subsidy, and the same can be told about the start-up businesses, as well.[5]

In addition to the above, it is definitely important to mention India, which has one of the world's most complex space programmes. The country, with its extremely ambitious plans, enjoys a high level of political support. Among India's plans is to develop its space capabilities by relying on its own human resources. The South-Asian country also plays an active role in the research of the Solar system.

The state expenditures for space related activities have been growing worldwide. In 2017 they reached the level on which the biggest space programmes operated during the 1960's (Apollo Moon programme, Soviet Union's world leader in human flights). Currently, more than 80 countries have their own satellites, including a number of Asian and African nations with emerging economies.[6] *Chart 2* presents the development of the global space economy.

Chart 2: The Global Space Economy (million USD)



Source: Morgan Stanley (2020): Haver Analytics, Morgan Stanley Research forecasts

The European Commission published its approved EU Space Programme (2021-2027) on 12 May 2021, which aims to ensure the continuity of investments in the EU space activities, encourage the academic and technical development, and support the competition and innovation capabilities of the European space industry.

The new programme combines the existing infrastructure and services, extending those with new functions in the following fields:

- Ensuring the continuity of Galileo and EGNOS (the EU global and regional satellite navigation systems) and Copernicus (Earth Observation) programmes.

[5] See also: BRYCE Space and Technology, Start-Up Space Update on Investment in Commercial Space Ventures, 2020

[6] See also: OECD (2019), The Space Economy in Figures: How Space Contributes to the Global Economy

- Elaboration of new security systems, for instance Space Situational Awareness (SSA) programme and new governmental satellite communication programme (GOVSATCOM), which ensures access to safe satellite communication of national authorities.
- Increasing the role of small and medium-size enterprises and start-up businesses in forming the European space industry.
- Preserving EU's autonomous access to space.

Expanding the GSA portfolio, which oversees the EU's Galileo satellite system based in Prague, in 2018 the EU has decided to establish the EU Space Programme Agency (EUSPA) in 2021. According to the previous plans the number of employees at the new agency can be increased up to 700, while maintaining the headquarter in Prague. The most important task for the agency will be the implementation of the European Union's Space Programme.

The importance of the space sector is well indicated by the fact that the EU has allocated almost EUR 3 billion more for the development of the sector in the new budget period 2021-2027 compared to the period 2014-2020. The overall budget of the Space Programme for the period 2021-2027 is EUR 14.8 billion, compared to the previous EUR 12 billion financial framework.

Distribution of the multiannual financial framework (EUR 14.8 billion) of the EU Space Programme for the period 2021-2027:

- Galileo and EGNOS programmes: EUR 9.01 billion
- Copernicus programme: EUR 5.42 billion
- SSA, GOVSATCOM programmes: EUR 442 million

The European Union has made a record financial commitment (EUR 95.5 billion) for the budget period 2021-2027 under the Horizon Europe framework programme. The programme, which was launched in May this year, is an integral continuation of the previous seven-year cycle of Horizon 2020 framework programme, on the other hand it is extended with new elements, such as cluster programmes encouraging cross-sectoral and cross-technological collaborations (digital economy, industry and space cluster), addressing the most important social challenges of strategic initiatives co-financed by the EU, Member States and industry, European partnerships.

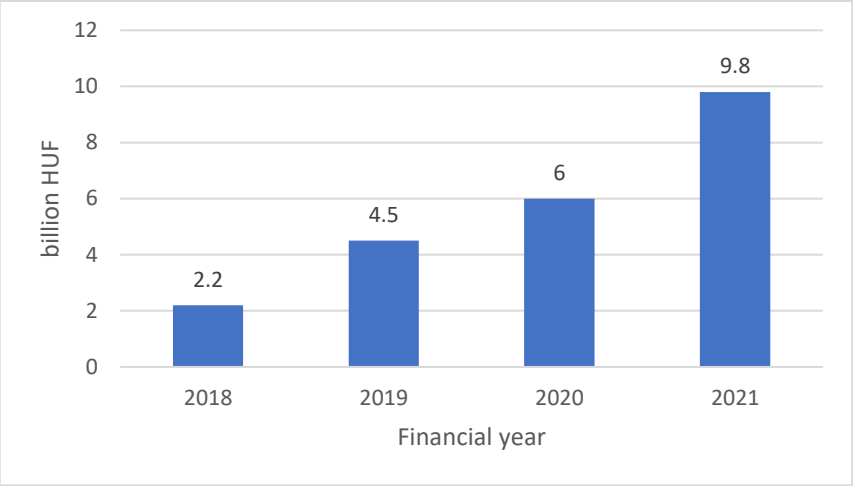
The planned blanket sum of digital economy, industry and space cluster, which aims for the development of space activities, also exceeds the resources allocated for development goals in previous years. The cluster enables universities, research institutions, small and medium-size enterprises, start-up businesses to efficiently connect to the European space sector through targeted financial resources. It is important to emphasize that the prerequisite of long-term successful participation for the actors of the Hungarian space industry both in the thematic tenders of EU Space Programme and in the call for applications of Horizon Europe framework programme, is the implementation of the action plan stated in Hungary's Space Strategy. With help of the state's role, the space actors strengthened through projects will be able to bid in thematic tenders of the EU Space Programme with higher effectiveness in the future.

Hungary's situation

The technological development has opened the possibility for smaller countries, such as Hungary to utilise space. From the region, Romania, Czech Republic and Poland also increased their budget in the field, and except the Czech Republic, each country has its own space agency, while Hungary, at a dynamic pace, is trying to catch up on its backlog observable on regional level *(Chart 3)*. It is a realistic

goal for Hungary in the medium term to have a regionally determining space industry, and the intensity of its space activities should be stable and sustainable in all aspects, like in the countries with similar population and capabilities in Europe. The competences in Hungary provide ample ground for this, and the conditions for the development of the domestic space sector are also given.

Chart 3: Development of budget expenditures directly spent on space research and space activities in Hungary between 2018-2021



Source: Ministry of Foreign Affairs and Trade (MFAT)

Based on the OECD survey, in the GDP-ratio in 2017, Poland has invested twice, Romania 3.5 times and Czech Republic 5.5 times more in the space sector than Hungary.

The production and operation of launch vehicles is a spectacular, however, not the most significant sector of the space industry Today, a number of countries and private enterprises offer payload sales as a service, and the competence has already appeared in our region. (In the near future Poland will be able to launch microsatellites on Low Earth Orbit (LEO) by self-manufactured and operated rockets.) Hungary currently cannot aim to become a primary actor in this industrial subsector. However, Hungary cannot rule out that with the expansion of this market, domestic companies will be able to join in the supply chain of launch vehicle production and operation on the world market, by manufacturing material technology, communication appliances and electrotechnical equipment.

The Information and Communications Technology (ICT) sector is a significant[7] user of satellite technologies, i.e. almost without exception they use and offer services, which are based on objects operating in outer space.[8] In Hungary, 3.4% of the employees work in the ICT sector.

The finding concerning the ICT sector is particularly important in light of the fact that companies with capabilities based on objects operating in outer space, in its entirety, will certainly play a significant role in generating domestic GDP. Unfortunately, it has to be acknowledged that such surveys have not

[7] It is worth noting that according to the European Commission's calculations, between 2011-2019, six times more (by 40%) jobs were created in this sector than as the number of employees has increased (by 6.9%) in the European Union.

[8] Based on the Eurostat's estimates: Denmark, Ireland, Greece, Spain, Croatia, Italy, Latvia, Lithuania, Luxembourg, Portugal, Romania, Slovenia, Iceland, Turkey.
Source: Eurostat (online data code: isoc_sks_itspt)

yet been conducted in Hungary, this gap needs to be filled, as the services of the space sector are determining for the world economy, and thus for the Hungarian economy, as well.

The progress of the space sector would ensure a good basis for economic development in order to organically create and operate Hungarian companies, whose revenue is entirely linked to the space industry.

The economy in the 21st century is unimaginable without the space sector. According to Morgan Stanley's prognosis in 2020, the global sales revenue of the space industry will increase from the current USD 350 billion to over USD 1,100 billion by 2040, hereby it will be one of the world's fastest growing industries in the coming period. According to the European Commission's survey, 10% of all EU policies and sectors are currently being affected by space activities, and this proportion is expected to increase rapidly in the upcoming years. According to the European Space Agency's estimates, every euro invested in the space sector shows six times return, as multiplied profits are realised in the economy through the complex supplier system.[9] Besides, NASA calculates eight times return on investment in the US economy. Priority areas of the global economy depend on space, such as global telecommunications, internet, as well as crop, water and climate observation built on Earth Observation data, meteorological services, precision agriculture or satellite navigation.

New global services have already appeared, in which competition is still open to Hungary, as well. Such as space weather forecast (with accurate forecast, it is possible to protect space objects, terrestrial electric and many other infrastructures from the devastating effects of solar flares), space exploration and exploitation (asteroid mining - the Czech Republic and Luxembourg intend to pay special attention to this in the coming years), space chemistry or space biology (chemical and biological experiments in microgravity that can revolutionise, for example pharmaceutical production, the fight against antibiotic resistance and other diseases), or communication around the Moon that gain importance by the planned "colonisation" of the Moon. Hungary has the appropriate high level of expertise in all these areas, on the basis of which, it can enter into these new innovative service sectors. It is important to emphasize that the results of research and development carried out here, can also be used extensively in other areas of the national economy.

The utilisation of the Moon with today's space activities is at the heart of the efforts due both to industrial and security policy reasons. It is therefore of particular importance that our country be present in the area of drastically growing services and technology in the Cislunar space. Hungary has been invited to participate in a mission to implement joint Earth-Moon communication as a service with Airbus and ESA.

In terms of national security[10], modern warfare, border surveillance or intelligence is unimaginable without space objects. Today, this competence is available not only to the great powers. More and more smaller states, for example Belgium, Bulgaria, Greece and Israel, posses their own satellite capabilities suitable for these purposes. Strategic independence and defence capabilities of countries increase through the possession of space objects. At the same time, it is a fundamental sovereignty issue that these space objects are built by reliable suppliers, considering national security aspects, namely from domestic production. Currently the Hungarian space sector is able to produce such objects, however, with greater state resources and well managed improvements, this capability can be made even more robust.

[9] European Investment Bank (2019): The future of the European space sector

[10] A separate chapter deals with the national security aspects.

Significance of foreign policy

International cooperation is an important component of space research and space activities. The governmental control of the domestic space sector was transferred to the Ministry of Foreign Affairs and Trade (MFAT) in 2018, under which the Department for Space Activities has been established. Thanks to the changes in management and broader support, furthermore building on the network of foreign representation of MFAT, its diplomatic and foreign trade activities, the Hungarian space sector has shown significant development in the past three years.

The MFAT has established the Hungarian representation in the various expert task forces of the ESA, the European Union and the United Nations (UN). It also signed declarations of intent and memorandums of understanding aiming at developing space research cooperation, respectively with the ministries responsible for this special field in Brazil, South-Africa, Israel, Portugal and Turkey, with the French Space Agency, Singapore Space and Technology Association, and the US-based Virgin Galactic Holding company.

The Hungarian-Russian Scientific Joint Committee was established in cooperation with the Russian Space Agency (Roscosmos). The framework for cooperation between the Government of the Republic of Hungary and the Government of the Russian Federation, is provided by the convention on cooperation in the exploration and peaceful utilisation of outer space, signed on 20 October 1999 in Budapest.

Space research should be a priority area for the government.

In outer space, research is not just valuable in itself. Through participation in research, and the developed objects and/or knowledge, the Hungarian space companies will have “space heritage” that is a prerequisite for entering the world market. Participation in the missions of ESA, NASA, Roscosmos, etc., may establish those space companies that typically produce for export, manufacture high added value products or services.

Following the period of lack of resources, on the initiative of the MFAT, the government in its decision 1133/2019 (March 18), together with the new resources allocated in the MFAT’s budget, increased the amount available for domestic space research and space activities to HUF 4.5 billion. In 2020, this amount was increased to HUF 6.8 billion, while in 2021, it has almost reached HUF 10 billion *(Chart 3)*. As a result, the determining space companies in the sector doubled the number of employees.

By providing predictable and stable financing, a wide range of opportunities based on the described potentials can be opened up to Hungary and the Hungarian actors of the space industry.

State incentives have clearly turned the Hungarian small businesses, often closely linked to research institutions, universities, to produce marketable products with their knowledge that has obviously strengthened the market- and competition-oriented operation of Hungarian companies in the sector.

In practice, the repair and fixing of space objects is not possible, and even if it were, it would not be economically viable. In addition, the components of space objects have to operate in extreme, non-terrestrial environments, often for decades, therefore space industry customers and integrators only use already tested and proven objects, solutions and suppliers with references.

Since the change of direction in the Hungarian economic policy in 2010, in a number of cases, it has built up effective incentive systems and supportive mechanisms for the benefit of certain subsystems

of the economy. Definitely, following this line is necessary desirable for the service sector utilising space industry[11] and space technology, due to its intrinsic characteristics.

Experiences of developments in the domestic automobile industry show that they do not aim at creating new Hungarian car manufacturing companies, but aim at increasing the integration of Hungarian small and medium-sized enterprises into the supply chains of international multinational economic actors. Moreover, building up the production capacities of international large enterprises in Hungary, and parallelly their state promotion are important aspects. Another important goal is to establish automobile research and development departments in Hungary by incentive tools.

The example of the automobile industry is important, as the Hungarian achievements in this field, regarding rather their structure, and not necessarily their financial volume, can serve as an example for other sectors, such as the space industry. Nor should we ignore the fact that the research and development aspects of the automobile industry are also linked to space industry developments at a number of technological points.

The Hungarian space sector is built on the small and medium-sized enterprises. Based on the surveys conducted so far, it can be stated that about 40 companies[12] are engaged in some sort of space activities, and are part of the space industry supply chain. Thus, it cannot be said in principle to be determinant for the economy as a whole, but the regional examples show that its importance is growing extremely fast after effective state intervention. Based on data of the Hungarian Central Statistical Office on the net revenue in 2019 by the category of number of employees, it can be stated that compared to the average of companies (with similar number of employees) in the national economy, the revenue of companies performing in the space industry is higher, from which the micro-enterprise category with 1-9 employees is an exception *(Tables 2 and 3)*.

Table 2: Average net revenue by category of number of employees

Categories by number of employees	**Average net revenue based on their latest report (million HUF)**	
	Total economy (2019)	Space industry respondents
2-9 employees	78.8	11.5
10-49 employees	659.6	780.5
50-249 employees	4 686.9	7 074.0
Total*	**252.6**	**1 869.4**

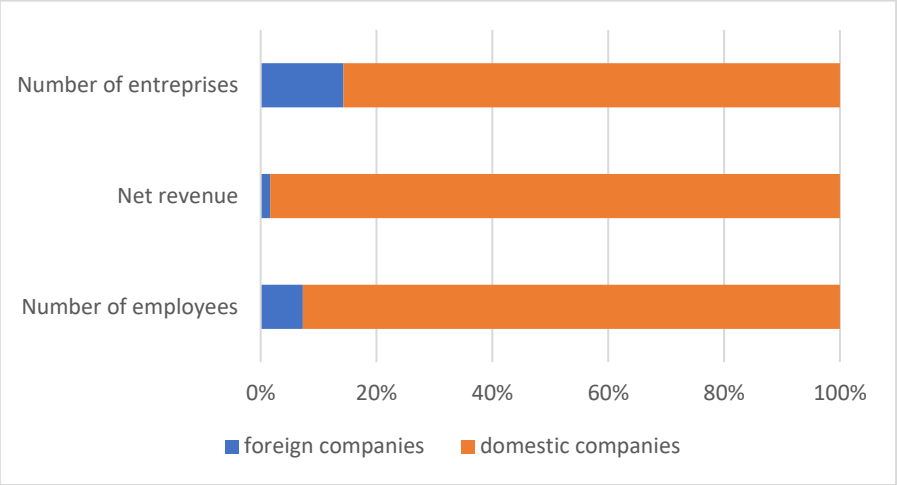
Source: Hungarian Chamber of Commerce and Industry (HCCI), 2021

[11] When we are talking about the Hungarian space industry, we mean space industry businesses and space economic actors in the narrow sense, thus for instance we do not count the ICT sector, even though its operation is unthinkable without the space technology.

[12] The company database, which formed the basis for the preparation of the Strategy, was created in several steps: Based on the data available in the Hungarian Space Caleidoscope 2019 and 2020 space catalogues, published by the Hungarian Astronautical Society, a total of 21 companies were identified in 2019 and 2020. The members of HCCI's Defence Industry and Space Technology section, and the companies in the sights of MFAT's Department for Space Activities further expanded the scope of examined companies. Currently, there are around 40 companies performing in the space industry in Hungary according to HCCI's survey in 2020 and 2021.
https://www.mant.hu/kiadvanyok/HungarianSpaceCaleidoscope2019.pdf and
https://www.mant.hu/kiadvanyok/HungarianSpaceCaleidoscope2020.pdf
The availability of sector specific statistical data would support significantly the progress of survey and research work related to the theme.

Remark: Size categories according to the SME thresholds, based on the EU recommendation in force since Hungary's accession to the European Union (Act XXXIV of 2004).
* Average net revenue of companies in the national economy and average net revenue of respondent companies performing in the space industry based on their latest reports (in million HUF).

Table 3: As regards the space industry, the ratio of foreign and domestic companies, the number of companies, their net revenue and the number of employees[13]



Source: Hungarian Chamber of Commerce and Industry (HCCI), 2021

Hungary's comparative advantages and areas to bring up to level

Comparative advantages of the Hungarian space sector include the positional advantage due to its strong fundamentals, which is embodied in professional know-how spanning three quarters of a century, and in the academic staff available in higher education. Building on the experiences of Hungarian researchers and scientists is at an advantage over those countries that do not have such a long history in space activities. The ***competences are diverse***, and ***can be utilised extremely well*** to this date. [14]

Traditionally Hungary is Budapest centred, but research institutions are not solely located in the capital; ***nation-wide coverage*** is ensured. Obviously, Eötvös Loránd University (ELTE), Eötvös Loránd Research Network (ELKH), University of Public Service (UPS), Budapest University of Technology and Economics (BME), Óbuda University, the most important space companies and several small and medium-sized enterprises can be found in the capital, while within the space sector there is considerable research and industrial potential in Sopron, such as Institute of Geodesy and Geophysics (GGI), furthermore in Northern Hungary, the University of Miskolc and University of Debrecen play leading role in Hungarian space industry. There are also significant research activities and capabilities

[13] Compared with the latest available HCSO (2018) data and HCCI corporate survey data, it can be stated that the rate of domestic companies performing space activities within space sector is 92.5 percent that is lower compared to 97.4 percent shown in the national economy. However, the domestic corporate contribution to the revenue generated by the sector is substantially higher than 51.2 percent shown in the national economy: it is 98.35 percent, while 92.7 percent of the employees in the space sector can be found in Hungarian-owned companies, which is also higher in terms of the 74 percent employment rate of Hungarian-owned companies in the national economy.

[14] Regarding corporate competences, it should be noted that the companies involved in the HCCI's surveys in 2020 and 2021, have been operating for an average of 20 years, the oldest enterprise performing in the space industry was established in 1981.

at the University of Győr and University of Szeged.[15] All the medical universities in Hungary, such as Semmelweis University, University of Szeged, University of Pécs and University of Debrecen, are active in space biology research.[16]

The results of student competitions also show ***high professional standards***, demonstrating that there is adequate expertise for development in the existing structures, it is not necessary to start all development concepts from the grounds. This is also proved by the fact that Hungarian institutions and their researchers successfully participate in ***international research collaborations***, including cooperation with ESA, Russia or other collaborations with several technical brilliance (ESA Rosetta mission, Chibis research satellite, SMOG-1 and ATL-1 picosatellite). The ***highly qualified researchers with project experience*** and ***extensive network*** have several competences enabling them to participate in international projects, and the capabilities of professional institutions cover almost the full spectrum of space activities. Hungary has significant results in the field of dosimetry and space weather research.[17]

In addition to the sphere of researchers and universities, the private sector also carries out ***successful downstream activity*** by processing and evaluating data, and it is worth mentioning here the state-owned Antenna Hungária, which provides services in the field of satellite broadcasting. As elements of the associated ***research-technology / practical infrastructure,*** ground-based objects are available that are capable for satellite communication. In addition to broadcasting, it is worth highlighting the station in Taljándörögd operating since 1978, and also the antennas of ELTE and BME.

Although there are not many ***small and medium-sized enterprises***[18] , in the meantime they are highly ranked when it comes to supplying to international markets and state-owned companies. This also applies to the field of electrical, communication and material technology. Many space industry actors in Hungary have attained the ***highest technological readiness level in the space industry (TRL 9)*** with their domestically developed objects which have shown to ***work successfully in space***. Surveys show that manufacturers and suppliers in other industries have space industry capacities and revenues.[19] According to the survey data in 2020, a majority of the companies manufactured metal processing products or components, while according to the survey in 2021, they contributed to the sector mainly by planning and engineering consultancy.

[15] According to HCCI's survey in 2021, out of 23 companies performing in the space industry, 7 companies operate in Budapest, while 16 firms operate in other 11 Hungarian settlements.

[16] According to the joint survey of the Ministry of Foreign Affairs and Trade and the Ministry of Innovation and Technology, from Budapest BME, ELTE, UPS, Óbuda University, Szent István University, Semmelweis University and University of Art and Design, while from the regions University of Szeged, University of Pécs, University of Debrecen, University of Miskolc, Eszterházy Károly Catholic University, University of Sopron and John von Neumann University in Kecskemét indicated that they have competences in the field of space activities. If further answers come in to the survey questions, this list will certainly expand.

[17] Companies performing space activities employ highly qualified staff, which calls attention to knowledge intensity. In the 2020 survey of HCCI the rate of graduated intellectual staff is 38 percent, while in the 2021 survey this rate is 60 percent.

[18] More than three quarters of space companies involved in the HCCI's survey is export company, more than half of their 40 percent sales came from export in 2020. The respondents have listed 18 different countries among the most important export target countries. The most often mentioned target countries were Germany, Austria, the Netherlands and Switzerland.

[19] According to HCCI surveys in 2020 and 2021, averagely 34 or 35 percent revenue of the respondent companies performing also in the space industry, can be attributed to space activities. According to HCCI survey in 2020, the average net revenue is HUF 717 million, while based on the survey data in 2021, it was HUF 1962 million.
HCCI (2020): *"Survey of space activities in the HCCI's Defence Industry and Space Technology section",* and HCCI (2021): *"Survey of space activities among companies participating in the sector"*.

The European Space Agency is Hungary's most important international partner. Since its 2015 membership, Hungary had the opportunity to learn about ESA's operating mechanism and procedures. This experience and know-how can further increase the efficiency of industrial and scientific development efforts in the future, building on the opportunities within the organisation.

The ***processing and use of Earth Observation data*** generates an astonishing amount of data, the benefits of which can be observed in several economic, governmental fields (disaster management, border protection, migration, agriculture, energetics, road system, monitoring of climate change, etc.). The processing and systematisation of these data should be highlighted in terms of digitalisation and digital economy, making it an important aspect of increasing the number of educated users in certain sectors.

As a member of the EU, Hungary has access to services of Copernicus, EGNOS and GovSatcom. In this ***cooperation***, the competences may be useful during building and operating systems other than those listed.

It can be seen in a number of areas that serious synergies can be exploited if the infrastructures built and existing services are not solely used for a single purpose, but a certain part of data and functions is shared between ***civil and security actors***. Such cost-effective solutions appeared already in Hungary, although not in the field of space sector.

Difficulties in ***long-term planning*** hold back Hungary's enhanced participation in more international programmes; therefore, it should be mentioned among the areas to improve. Public financing of the Hungarian space activities is resolved in the actual Finances Act. The membership fee payable to ESA, financing of international agreements, a project can last for decades, these issues do not allow annual negative adjustment, not to mention the increase in public expenditures in this area worldwide. Such political decisions may lead to serious diplomatic problems, loss of domestic competences and, as a last resort, the suspension of our ESA-membership. In order to avoid these obvious damages, ensuring public financing of space activities guaranteed in the long term, is necessary.
Basic research is converted relatively quickly into market services and products that can be fostered by eliminating the defects mentioned above.

Enterprises and research institutions need access to additional information on the ***operational mechanism*** of ESA ***optional programmes***, therefore Hungarian participation has to be facilitated through personal conditions and diplomatic means. A similar ***lack of connections*** can be experienced, as it is not generally known that domestic industrial actors – not only the space industry actors – have the opportunity to participate in such tenders. While 80 percent of the ESA applications are industrial, the opportunity is also offered for enterprises of the Member States to develop new, space objects with the ESA experts' support.
Only a few Hungarians work in EU organisations coordinating space activities and in the ESA. A common problem in the EU is that leaders from Central and Eastern European countries that gained access later, are underrepresented. It is also valid for the field of EU space programme, and in case of international collaborations for defence purposes (e.g. EDA, NATO) that makes ***enforcing interests*** more difficult.

The ***lack of financial resources*** makes ***participation*** of small and medium-sized enterprises ***difficult*** in ***international*** manufacturing projects, as domestic space companies are mostly micro and small enterprises, merely some medium-sized enterprises are active. In order to strengthen them and to obtain space heritage, there is a need for supporting companies with real market potential. There is a

gap in the experiences of tender-writers, and the actors have to fulfil administrative tasks along with their scientific and technical abilities that is a bottleneck in the system.

Despite the availability of several workshops and competences, the number of lecturers and researchers engaged in the space sector is low. The increase of reliable human capacities is one of the most important needs of companies, thus the ***existing relative lack of professional human capacities, the slow professional recruitment compared to the needs***, must be solved. One of the reasons for all this is that the educational and research institutes at universities and ELKH also struggle with ***infrastructural deficiencies***. These effects are also reflected in domestic training of specialists, in addition to the fact that ***public knowledge about the space sector is also insufficient***. It has to be presented to the Hungarian society that today space activities are part of people's daily lives (navigation – Galileo, GPS, GLONASS, Beidu –, telecommunication, internet, etc.). Likewise, public education also lacks space research and space activities, as an important ***scientific knowledge*** with socio-economic significance.

A problem, which in most part has been solved since 2018, was that in the early years after Hungary's accession to ESA, our country did not allocate enough funds to be able to participate in its programmes. The same was true for the lack of funding of bilateral programmes, such as Hungarian-Russian projects. Due to the ***practical*** element of space research and space activities they could only be carried out as part of international cooperation, which meant serious problems for educational and research institutions, as they could not be connected to space research missions and developments in earnest. Neither ELKH institutes nor ***retention capacity of the academic sphere*** alone are sufficient to ensure adequately qualified professionals in the field of training and research. Through the governmental development of domestic space research since 2018, Hungarian researchers can join more international projects that definitely fosters financing their operation.

Among the research institutions of Hungarian Academy of Sciences (MTA), although many of them were involved in space activities, neither ***space research*** was listed among the ***declared objectives of the Academy***, nor a separate ***organisation dedicated*** to space research activity existed. The formation of the Eötvös Loránd Research Network has brought changes, and the current processes give hope for the establishment of a professional institute engaged in space research.[20]

Technological capabilities of the research teams could be used in several other areas than space research, however, the ***well-functioning platforms*** needed for handover and resolving ***isolation*** are missing. The isolation of economic actors, their operational models, the ***lack of*** practical experiences of research institutions, hinder dissemination of space research results and new services to other stratum of society. However, there are positive examples, as the establishment of domestic science parks and national laboratories.[21] In addition, the Hungarian space industry groups need considerable ***organisational*** development, as in their current form of operation, they have ***limited*** ability to funnel

[20] Astronomy, as mostly classical basic research exploring and analysing worlds beyond borders of the Solar system, is not considered space activity. One of the structural problems of domestic space research is that, for the public opinion, astronomy and space research are not clearly separated as scientific areas, and regarding the latter, as a practical space activity.

[21] According to the results of HCCI survey in 2021, three quarters of the participating companies cooperated with a state or non-state actor in an activity related to space sector. Majority of the companies reporting on the cooperation collaborated with other domestic companies performing space activities, domestic university or other higher education institutions. 9 out of 16 companies reporting on the cooperation, highlighted a university or research institution among their most important partners.

their important issues into the decision-making processes, this way the sectoral needs are not articulated for the decision-makers.

Transfer of social education and knowledge help understanding the importance of the sector. The supportive social environment has a positive impact on development of the whole space sector. It is a general concern that social knowledge about economic, technological possibilities in the space sector is low, therefore domestic economic and governmental actors do not use the potential in the new space sector or to a lesser extent than possible.

The current structure of universities and research institutions, the ***administrative and bureaucratic barriers*** on the actors make the utilisation of space research development or project grants difficult in a number of cases. The current efforts to transform higher education, through the setting up of new institutions give hope to eliminate the problem.
The time factor is of great importance in the space sector and related data processing. ***Bureaucracy*** experienced in the field of public procurement unnecessarily prolongs procuring processes for data submission. Waiting for data for days, weeks in a specific situation such as flood prevention, makes the process itself pointless, therefore for these cases, applying new protocols or introducing new rules is needed.

The space-based technologies used by Hungary's economic and governmental actors are not owned by the state or domestic companies. ***Exposure to*** commercial ***service providers*** is associated with risks.

Situation of national defence

In Hungary, in line with international trends, the development of the space sector is basically determined by civil and economic needs in conformity with the increase of proportion of space technology services and the dependence of economy and society on them. In parallel,

the space sector, space technologies and services based on them are playing an increasing role in the functioning of national defence and national security.

If it counts with defence and national security aspects, strategic planning aiming development of space sector can develop associated space-based services and the ability to manage potential threats and risks, strengthen resistance of the entire space sector and economy, and keep pace with international developments with regard to allies, partners and other actors.

Justification for the development of space activities for defence and security purposes

International practice shows that ***space infrastructure and related services are defined as critical infrastructure***, and are protected and developed accordingly in several countries. There are three main reasons for this:

- The outer space, ***space sector and space research are now so closely intertwined with the whole economy*** and certain sectors within it that its protection is tantamount to protecting the economy as a whole, furthermore it is an integral part of the functioning of our society, for example through navigation and communication.

- Space sector is not only one of the pillars of our economy, but also an important element of the country's modern national defence. ***The modern defence sector and activity cannot do without the utilisation of space technologies and space services***, whether it is forecast, preparation, planning, positioning and control, or even communication, all new defence systems and tactical tools strongly rely on the opportunities created by the space sector.

- Space sector has become highly important both at international and national level, and ***at further utilisation fields serving national security goals, especially in the field of modern border protection and modern disaster management***. Both fields strongly rely on services provided by space technology and data/information generated by the space sector. The number of critical utilisation fields is continuously growing, such as the climate change, cyber security, or the epidemiological utilisation of space technologies in connection with covid-19 pandemic.

In the light of the above, it is understandable that the National **Security Strategy, in accordance with NATO's position**, in addition to cyber security and other high technology areas, **addresses the importance of application and development of space technologies, as well as their protection**. It is important to point out that the effective implementation of Hungary's further security and defence strategic goals (National Military Strategy, Zrínyi 2026 National Defence and Armed Forces Development Programme, National Cyber Security Strategy, Report on Hungary's national disaster risk assessment methodology and its results, etc.) also relies on the utilisation of space technologies.

Taking all of this into account, **two main priorities** can be identified during situational evaluation as priority development areas:

- **Defence of space sector** in order to protect economy as a whole,
- **Utilisation of the space sector** in order to fulfil and support additional state, especially national security tasks, primarily to increase the effectiveness of border protection and disaster management measures.

Substantive dimensions of space activities for defence and security purposes

The security and defence use of space is an extensive and highly developing area. At international level, an increasing number of states and nations adapt and utilise this area. At least five countries in the European Union have a programme (and related strategies) for space activities for defence and security purposes, and additional at least 9 countries participate in related common European developments and/or begin to develop their own programme. In addition, the development of space technology will foster the expansion of a range of applying/entering nations.

Space activities for defence and security purposes basically include two aspects:

- **Space for Defence**
    - Intelligence, observation and exploration *(Earth Observation, signal intelligence, early warning, meteorology)*,
    - Satellite communication *(Positioning and time series data solutions, space observation)*.

- **Defence of Space**
    - Situational awareness of space operations,
    - Defence and preservation of space environment,
    - Security of space infrastructure (security regarding planning, operational security).

Situation of space activities for defence and security purposes in Hungary

The use of space and space technology can contribute significantly and positively to the achievement of national strategic goals and the early identification and management of potential risks/threats. At the same time, based on the international situational analysis, in particular on the situational evaluation of our allied system, the EU and NATO, it can be stated that hostile space activities can cause considerable threats to the national security of our country, especially in the economic, military, border protection and disaster management areas.

► **Defence of the Hungarian space sector**

In the field of "**Defence of Space**", the core tasks are performed by the Hungarian national security services and other actors operating in the field of critical infrastructure defence. In this area, for the next period it is worth preparing for the new challenges arising from the development of the space sector (such as more domestic actors, more international collaborations, cyber defence and other new types of challenges, etc.), and involving other relevant state actors. Successful defence of the space sector also presumes closer cooperation between civil and state actors in the sector that is in accordance with the general international trends in the space sector.

► **Utilisation areas of space activities for defence and security purposes in Hungary**

In the "**Space for Defence**" dimension, relying on the common European space infrastructure (e.g. Copernicus, the European Union's Earth Observation Programme) and the services of the market actors (e.g. Hungaro DigiTel and NISZ National Infocommunications Service Company), Hungary currently utilises decisively two activities:

- Earth Observation (remote-sensing) and
- Satellite communication (telecommunications / remote communication).

Depending on the target and method of data use, both fields can foster the implementation of more priorities at the same time, primarily in the military, border protection (e.g SUPERB project or Copernicus Border Surveillance managed by FRONTEX) and disaster management areas. In Hungary, the utilisation is organised independently by each organisation in the above-mentioned areas, from military cartography to flood prevention.

In Hungary, in addition to the few foregoing, there is a possibility for building new utilisation fields in the future, as Hungary does not have sufficient capacities yet in the field of signal intelligence, early warning and space observation.

Positioning and time series data solutions are the most frequently used, and from the management aspects, critical elements of space operation for defence and security purposes. The technical opportunities ensure the expansion of smaller regional systems instead of the currently widely used global systems demanding many space objects. National and/or regional allied ambitions that can be professionally integrated into a European regional system in the medium-term, will greatly contribute to the maintenance of operational capabilities.

The use of services of common European space infrastructure and market actors involves several risks, for example the threats of dual-use or traditional market contracts.

In case of any major catastrophe or conflict, the use of common European infrastructure can be terminated, which is a considerable risk for domestic space sector and economy as a whole, while

building up the national space infrastructure contributes to the formation of a higher degree of strategic autonomy and national sovereignty, and also strengthens the presence in allied systems and Pan-European capacities.

► **Organisation and governance of space activities for defence and security purposes**

The domestic development and use of the above-mentioned programmes do not rely on a consistent strategy / framework, in this context, it can be stated that

the domestic governance structure determining the utilisation of outer space and space technology for security and defence purposes, has not been uniformly defined yet, the institutionalised territorial cooperation between the organisations and ministries concerned, is not common.

The utilisation is organised independently by the involved domestic organisations through individual contracts, etc. The operation is characterised by insularity up till now. However, lack of a uniform governance structure has disadvantages (see individual contracting) that can pose significant risk in the future (see possible parallelism, lack of uniform planning process, etc.), and can hamper the successful development of the sector.

► **International cooperation and development in the field of space activities for defence and security purposes**

Space activities for defence and security purposes in Hungary rely mainly on the space infrastructure of the common European, NATO and NATO's allied nations, and **up until now, our country participated in few international collaborations** (EDA, ESA, NATO, etc.). However, it can be mostly explained by the early stage of domestic development of the area. Hungary participates in common developments in the EU, such as PESCO TWISTER project, EDA CIS project, and additional projects related to space sector are also planned. **Now international initiatives in the field begin to emerge, both in relation to the EU and NATO, offering new opportunities for domestic initiatives.** Cooperation within the allied system can be the backbone of space activities for defence and security purposes.

Budget of the European Defence Fund (EDF) could reach EUR 10 billion in the next planning cycle, and as a part of this, priority project development can be linked to space defence.

NATO has begun developing a relevant programme, and probably will initiate new activities. According to our commitments, Hungary's planned defence expenditures can reach 2 percent of the GDP by 2024. In this context, it will provide an opportunity to improve its space defence development activities.

► **Development of expertise regarding space activities for defence and security purposes (training, research, career/profession)**

Educational and research activities related to the area are currently in the foundation and development phase in Hungary where the domestic universities could serve as preferred locations for specialised trainings. These improvements can make the development of all space activities for defence and security purposes sustainable.

SWOT Analysis

Strengths	Weaknesses
Education ● 80 years of professional know-how, professionals in higher education ● National coverage ● High professional standards, competition results ● Participation in international research collaborations **Research** ● Highly qualified researchers with project experiences and connections ● Complex space research ● Successful downstream activity ● Strong research and technological / practical infrastructure **Manufacturing and upstream** ● Unique knowledge – international reputation ● TRL 9 objects and components proven in the space ● Manufacturing, supplier expertise and capacity that can be built on other industries **ESA** ● Know-how from membership **New Space and services** ● Core competences in processing and use of Earth Observation data ● Appearance of educated users in certain industries (e.g. agriculture) **National defence** ● Its development is at early stage, thus it is still flexible ● Knowledge and experience in allied cooperation ● Civil-military cooperation ● Specific relevant competences, borderlands	**Education** ● Challenges of professional resources and training of future professionals ● Lack of predictable financial resources in the long term ● Need for infrastructural developments, outdated assets ● Lack of practice-oriented education ● Defects in popularisation of space sector ● Challenges of scientific education of secondary school students, queries of teaching basic scientific competences **Research** ● Lack of long-term planning in consequence of financial reasons, up till now ● Challenges of unfavourable motivational, structural and workforce-keeper conditions of the research workforce ● Lack of experience in tender writing ● Weakness of the knowledge transfer platform ● Isolated research teams, technological isolation **Manufacturing and upstream** ● Issues regarding professionals and training of future professionals ● Weak cooperation between research and industry ● Infrastructural defects ● Lack of support and communication **ESA** ● Lack of experience in operation mechanism of optional programmes ● Lack of connection between ESA and the Hungarian industry ● Organisational underdevelopment of domestic industrial actors **New Space and services** ● In general, the number of educated user is low ● Use of sources is not effective ● Bureaucracy in public procurements, long procurement process of satellite data ● Challenges of issues regarding professionals and training of future professionals **National defence** ● Limited experience in the utilisation of space-based technologies and data ● Priority of user approach ● Defects in human resources, management and planning ● Exposure to commercial service providers ● Need for development of international enforcing interest ability

	● Resource allocation supports civil sphere ● Defence expenditures are incurred on an ad hoc basis (e.g. pandemic)
Opportunities	**Threats**
Education ● ESA projects ● Strengthening the connection among industrial-educational-research actors **Research** ● International tenders ● Continuous broadening of multi- and bilateral international collaborations, knowledge transfer ● Space sector is a continuously growing, crisis-resilient and profitable business ● High innovation potential with high rate of utilisation ● Space technology – critical infrastructure ● Increasing space industry sources ● New Space phenomenon ● Involvement of smaller countries is more emphasized **Manufacturing and upstream** ● Benefits of ESA membership ● Opportunities for regional cooperation ● Adaptability/openness to new directions **ESA** ● Programme for New Member States (NMS) to build competences ● Improvement of targeted competences through optional programmes ● Building new competences through compulsory and optional programmes **New Space and services** ● Increase in support for downstream within ESA ● Presence of CubeSats ● Fostering involvement of small nations in the EU ● Appearance of educated users in certain industries (e.g. agriculture) **National defence** ● Adequately scheduled accession to the EU-NATO common development processes ● Opportunities for regional cooperation ● Adapting to domestic development programmes ● Technological transformation, arrival of new actors, reduction of expenses	**Education** ● International “brain drain” phenomenon **Research** ● Researchers leave for industry or abroad (industrial “brain drain”) ● Strong vulnerability of the infrastructure in the sector **Manufacturing and upstream** ● Slow paradigm shift ● Discontinuation of protected status at ESA ● Strong product and expertise competition **ESA** ● Change of effective delegated arrangement ● Lack of designated space policy ● Strong competition among Member States **New Space and services** ● Strong competitors in surrounding countries with developed and broader network of contacts ● Major international actors dominate the market in satellite navigation and communications **National defence** ● Competition in common development programmes ● Predominance of dominant Member States

II. HUNGARY'S SPACE STRATEGY

II.1 Scope of the Strategy

VISION: HUNGARY IS A SIGNIFICANT INDIVIDUAL ACTOR IN INTERNATIONAL SPACE ACTIVITIES, BENEFICIARY OF BOTH ITS SOCIAL AND ECONOMIC IMPACTS								
1. Strategic goal **Utilisation of potential in space sector to stimulate innovation and sustainable growth in the national economy as a whole**				**2. Strategic goal** **Strengthening Hungary's international role, broadening its connections, and creating organisational frames of coordination**			**3. Strategic goal** **Development of knowledge-based social and economic conditions and infrastructural background that is essential for prosperity of the space sector**	
1.1 Strengthening multiplicative effect of the Hungarian space sector	***1.2 Building targeted competences in the segments with high market potential***	***1.3 Integration development of the space sector***	***1.4 Supporting sustainable development of the economy in the long term***	***2.1 Supporting Hungarian space activities through central coordination, institutional background and complex national communication***	***2.2 Strengthening Hungary's diplomatic positions, increasing abilities to enforce its interests***	***2.3 Fostering our role in international programmes***	***3.1 Long-term foundation and acceleration of human resources developments***	***3.2 Improving the operational and infrastructural conditions of the institutional system***
1.1.1 Tender-based support for R&D groups and enterprises (support for linkages of space companies and research centres)	1.2.1 Fostering incubation activities in space science and space engineering research and/or training sites	1.3.1 Horizontal and vertical data harmonisation, increasing data processing capacities (BIG DATA, AI, IoT, FIR-FOK, connecting Earth-Space data)	1.4.1. Promoting formation of a future-oriented economic structure	2.1.1 Building the structure of domestic regulatory, organisational framework and financial incentive system for space activities, creating the legal harmonisation in the EU	2.2.1 Strengthening regional role (Establishment of V4 Space Cooperation)	2.3.1 Supporting the expansion of Hungary's role in international research programmes (multi- and bilateral)	3.1.1 Introducing and maintaining secondary and higher education programmes, accredited space science and space engineering trainings with internships	3.2.1 Performance-oriented development and support for the operational background of educational and research institutional system

1.1 Strengthening multiplicative effect of the Hungarian space sector	*1.2 Building targeted competences in the segments with high market potential*	*1.3 Integration development of the space sector*	*1.4 Supporting sustainable development of the economy in the long term*	*2.1 Supporting Hungarian space activities through central coordination, institutional background and complex national communication*	*2.2 Strengthening Hungary's diplomatic positions, increasing abilities to enforce its interests*	*2.3 Fostering our role in international programmes*	*3.1 Long-term foundation and acceleration of human resources developments*	*3.2 Improving the operational and infrastructural conditions of the institutional system*
1.1.2 Tender-based encouragement of cooperation among enterprises	1.2.2 Supporting development of industrial and production capacities	1.3.2 Establishing internationally accredited test centre, standardising testing capacities	1.4.2. Improving economic competitiveness based on new technologies	2.1.2 Elaborating and operating an accreditation and monitoring system	2.2.2 Security policy role, strengthening capabilities and national integrity (EU, UN, NATO space defence)	2.3.2 Fostering international trainings, upskilling	3.1.2 Developing user capabilities related to space technology	3.2.2. Improving educational and research institute infrastructure, their technical and operational conditions
1.1.3 Promoting and supporting the establishment of spin-off firms	1.2.3 Supporting pilot projects for market-oriented use of research data, promoting trade activity	1.3.3 Incorporating data from space activities into a standardised system, establishing data centres	1.4.3 Strengthening Hungary's economic potential through increasing added value of space sector	2.1.3 Awareness raising, building of knowledge dissemination and support	2.2.3 Strengthening the role of Hungarian diplomacy in ESA/EUSPA	2.3.3 Ensuring personal and material conditions for international relations	3.1.3 Building interdisciplinary knowledge platform in space sector, dissemination of innovations, integrated interconnections of university courses	
1.1.4 Encouraging the shift towards a knowledge-based economy through knowledge- and technology-intensive investments	1.2.4 State incentive and support for competence development enhancing the efficiency of corporate management and strengthening the management approach	1.3.4 Resolving barriers to data access, supporting open data platforms		2.1.4 Launch of flagship projects (Hungarian research astronaut mission, individual satellite programme, Radiation Effects Testing Laboratory)		2.3.4 Reorganisation of ESA BIC-TTO centre and ESERO	3.1.4 Creating a researcher career model	

Vision: Hungary is an important actor in international space activities, beneficiary of both its social and economic impacts

Explanation

Hungary's strategic goal is to enable its economy to meet the challenges of the 21st century, and to increase its gross domestic product year by year in a sustainable way, steadily over the average in the European Union. In order to achieve this objective, the Hungarian government recognised that it needs to take incentive steps to modernise the economy making it possible to have as many businesses as possible in the country, capable of producing high added value.

Through the cooperation of governmental policy leaders and decision makers, society and economic actors, a sustainable ecosystem can be created, which is able to keep the Hungarian space sector entirely on the development path. The goal is to establish a well-functioning, solvent and competitive space sector, which, following phasing the initial state incentives out, will develop in an organic way.

The vision of Space Strategy is adapted to the economic policy objective of the government that protects domestic jobs, and facilitates the creation of domestic added value from innovative Hungarian ideas, supporting companies to make good decisions in the global technology change process. Through the implementation of the Space Strategy, the successful circle of Hungarian entrepreneurs will be created on the international stage which contributes to the economic development, and thereby, to the increase of the quality of life in Hungary.

Based on the vision of Space Strategy, Hungary is an active actor of the global value chain in the space sector in the long term, and plays a regional role in certain areas due to its position. Thanks to its promising, validated training system, it has a new generation of professionals with innovative, interdisciplinary knowledge, which supports the manufacturing of products with high innovation and added value, services, furthermore the development of space competences. With its multiplicative effect extending to more industries, and with the employment of qualified, highly educated workforce, the space sector contributes to increasing competitiveness of the Hungarian economy, thereby to the higher quality of life of the society, ultimately, to the common good.

1. Strategic goal: Utilisation of potential in space sector to stimulate innovation and sustainable growth in the national economy as a whole

According to a number of surveys and studies, the development of the space sector has a positive impact on modernisation of the economy and on social well-being.[22] The space industry is developing at an outstanding pace globally, so much so that today it is a significant sector of the world economy.[23]

[22] NATO Parliamentary Assembly Economic and Security Committee (2018): The Future of the Space Industry, General Report

[23] The future of the European space sector, How to leverage Europe's technological leadership and boost investments for space ventures, European Commission/European Investment Bank, 2019

The total value of investments in the space sector increased by USD 8.9 billion in 2020 in time of covid-19 pandemic. In the coming years, analysts expect another record amount of investment as a result of intensifying space activities of some mega-corporations, such as Microsoft or Amazon.[24] Over the next EU budget period, the EU itself will spend nearly EUR 15 billion specially for space activities.[25]

In order to achieve the goals, further strengthening the innovation potential of the Hungarian economy is needed, developing and dynamizing the research-development activities, as well as the knowledge intensive sectors by promoting them with state resources. In the previous period, the Hungarian Government has already succeeded in identifying the necessary conditions for this in some areas of the economy, as a number of sectoral strategies, programmes and incentive measures have been adopted and introduced in several economic areas. However, it is clear from the already completed sectoral documents that in all areas, it is necessary to lay the foundations for growth and to strengthen enterprises, furthermore to increase their numbers and economic weight in order to have a chance to appear on the world market.

In an export-oriented area where market access is equivalent to world market access, it is especially important to have Hungarian enterprises that can compete with even solvent large companies in the competition for market positions.

The growth rate of the domestic economy exceeds the average growth of the European Union. In order to allow the domestic economy to return to a sustainable growth path as soon as possible after the 2020 coronavirus crisis, the Government supports this process with the wide range of economic policy tools available.

Hungary's experiences in space activities concerning space history, provides a good basis for exploiting innovation potential in the sector. The reliability of the 140 Hungarian space objects put into operation so far is outstanding, which testifies the precise Hungarian engineering work. Besides, between 2018 and 2020, significant and promising bilateral and multilateral agreements have been concluded within the framework of the internationally recognised professional organisational innovation, by the Department for Space Activities of the Hungarian Ministry of Foreign Affairs and Trade.

The vision of the Strategy is in line with the vision of the Ministry of Innovation and Technology's Economy Development Strategy, which aims to improve the economy and increase the quality of life in Hungary. The Strategy is also in line with the goals of "The Programme for a Competitive Hungary package" of the Hungarian Government, particularly with encouraging the industrial diversification and higher value-added productive investments, furthermore the economic strategic objectives of the government in the field of digitalisation, which are also defined in the field of health, education and agrarian sector (Digital Agricultural Strategy). Thus, the Strategy supports functioning of a wide range of small enterprises assuring the living of many people, as well as strengthening its organising of society role.

[24] Space Capital, Space Investment Quarterly: Q4 2020, 2021

[25] European Commission, Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions Space Strategy For Europe

1.1 Specific goal: Strengthening multiplicative effect of the Hungarian space sector

Explanation

The national economic importance of multiplicative effect attainable with the development of the space sector, as a positive multiplier effect, substantially influences Hungary's long-term competitiveness in the era of technological change and digital switchover. Space sector has a catalyser role in the global economy.[26] It is not just one of the benefits of this steadily growing, innovation-driven and crisis-resilient industry[27] that in the long-term, it will also ensure high return: through its positive multiplicative effect, many other industries can benefit from the developments.

However, cooperation between the actors is an important prerequisite for the development of the space sector. If the actors know each other's competences, references, resources, projects, and build on each other's strengths, successful cooperation will be possible. Recognition of the benefits of cooperation, can result in growing domestic participation in projects, and in a wide-range of cooperation, including international projects, as well, which assumes cooperation not only between educational institutions and research centres, but cooperation among industrial actors, too. Through exploiting synergies, as well as improving tender efficiency and mutual support between themes, new market perspectives will be opened.

The linkages between research and manufacturing phases have moderate impact on the fragmentation of value creating processes of the domestic space sector, while increasing impact on their effectiveness.

Knowledge- and technology-intensive investments in the space sector support the income growth in the economy. At the same time, expertise accumulated through the projects and knowledge-transfer have repercussions, thereby strengthening the multiplicative effect of the space sector. It should be noted that in the innovation-driven space sector, the high value-added work-places and the knowledge-intensive activities of mostly domestically owned companies, will allow the production of high added value. Based on the HCCI surveys in 2020 and 2021, in terms of their ownership structure, more than 90 percent of the companies in Hungary are wholly domestically owned companies.[28]

Exploiting the positive synergies in the sector is also supported by the assurance of adequate coordination mechanisms and communication channels, whereby information asymmetries can be reduced.

In the process of accumulation of knowledge and information that changes the foundations of production, one of the most significant areas is the rapidly expanding knowledge of the space sphere and space industry. It can be rightly stated that the knowledge-based society and economy are an

[26] Morgan Stanley (2020): Investing in Space, https://www.morganstanley.com/ideas/investing-in-space. The Hungarian results achieved in the period 2018-2020 clearly fit into the economic, social and scientific framework that the Council of the European Union formulated in a document dated 10 May 2019. The Council of the European Union points out the catalyser role, which the space sector performs in development of the society and economy: based on the documents of the Council of the European Union, No. 8999/19 and No. 9248/19 dated 17 May 2019.

[27] PWC (2020): Resilience of the Space Sector: Resilience of the Space Sector to the Covid-19 Crisis, In more details: https://www.pwc.fr/fr/assets/files/pdf/2020/05/fr-france-en-resilience-of-the-space-sector-to-the-covid-19-crisis.pdf

[28] Knowledge-intensity is shown by the fact that employees with higher education are overrepresented among all the employees in the sector: 60 percent of the employees of the participating companies in the HCCI survey in 2021 were employed in intellectual area of work requiring a higher degree, while in the entire national economy, based on HCSO data of the fourth quarter in 2020, 25 percent of all employees hold higher degree.

important and integral part of it, even if the space sector in Hungary is only a small part of the whole spectrum of economic activities.

This new knowledge represents from every aspect that our world is becoming more and more complex, which calls for analytical exploration of interdisciplinary relations, rethinking of foundations and creation of fusion among various sciences. Only through this will the sciences, especially social sciences be able to meet the new challenges. In parallel, it is an important requirement for investments in the space sector and space industry to be knowledge- and technology-intensive[29]. In addition to favourable added value effects, it is also important for the supplier companies to have an accelerating leverage to the development of small and medium-size enterprises, as opposed to the current slow progress. It is an encouraging starting point that the revenue of space companies was HUF 39.3 billion in 2020, according to the HCCI survey in 2021. Thus, in the long-term the expansion of necessary productivity can be reached in broader circles of the national economy, which will contribute to increasing social welfare.

Related measures

- I.1.1 Tender-based support for R&D groups and enterprises (support for linkages of space companies and research centres)
- I.1.2 Tender-based encouragement of cooperation among enterprises
- I.1.3 Encouragement and support for spin-off companies
- I.1.4 Encouraging the shift towards knowledge-based economy through knowledge- and technology-intensive investments

I.2 Specific goal: Building targeted competencies in the segments with high market potential

Explanation

The international visibility of the actors and competences of the Hungarian space sector is low,which creates a significant barrier to joining in the international value chain, and exploiting the benefits from international knowledge transfer. If the domestic economy is able to better and specifically use the multiplicative effect of space sector, it will substantially support the pre-integration / progress in the value chains and increase in the domestic added value. Targeted competence building and competence development are needed, which lead to more efficient utilisation of resources in a wide spectrum of corporate value-creating processes, and thereby result in process optimisation. The process optimisation in itself yields productivity growth.

Related measures

- I.2.1 Promoting incubation activities in space science and space engineering research and/or training centres
- I.2.2 Supporting the development of industrial and production capacities
- I.2.3 Supporting pilot projects for market-oriented use of research data, promoting commercial activities

[29] Regarding technology intensity, it should be noted that companies in the national economy spend on average 1 percent of their revenue on development and innovation, while companies in the space industry spend about 11 percent on development and innovation, while in 2020 this proportion was 21 percent as a result of higher rate of companies providing engineering services and planning.

I.2.4 State incentive and support for competence development enhancing the impact of corporate management and strengthening the management approach

I.3 Specific goal: Integration development of the space sector

Explanation

Services built on satellite data became determining elements of critical infrastructure, without which, the disaster management or the military would not be able to carry out their tasks. The extent of data-based economy and society is well illustrated by the fact that satellite data is used as a precondition for overcoming the most significant problems in the 21st century. Developing services built on satellite data and producing own satellite data have considerable importance considering Hungary's sovereignty. In this respect, it is efficient to create the conditions both for state and market use of satellite data.

As satellite data became part of everyday life and critical infrastructure, it is highly important in terms of sovereignty and national security that the state obtains data from an actual and authoritative source, through a reliable channel.

Through promoting widespread agricultural use of innovative technologies and services built on satellite data, more efficient production can be realised. Therefore, the income-generating capacity of business entities is growing, moreover, the climate protection and environment protection considerations can be better applied.

As the CubeSat segment transforms the space sector, indispensable infrastructures related to it provide a unique breakout opportunity for Hungary. It is recommended to establish a CubeSat assembly, integration and test centre that is regionally outstanding, qualified for most carriers, provides complex services, and fulfils the increasing CubeSat capacity requirements in the region.

Related measures

I.3.1 Horizontal and vertical data harmonisation, increasing data processing capacities (BIG-DATA, AI-, IoT-, FIR-FOK-, connecting Earth-Space-data)
I.3.2 Establishing an internationally accredited test centre, standardised testing capacities
I.3.3 Incorporating data from space activities into a standardised system, establishing data centres
I.3.4 Resolving barriers to data access, supporting open data platforms

I.4 Specific goal: Supporting sustainable development of the economy in the long term

Explanation

The impact of the space sector and space industry on sustainable development can be interpreted in the context of global development megatrends affecting the process. Among the current 17-20 megatrends[30], related to the space sector, first of all, it is reasonable to take into account the restructuring effect of 6-8 megatrends, and to incorporate their goals into the domestic model of sustainable development. These megatrends are the following:

[30] In detail, About the global megatrends, Virág, Barnabás (2019). Hungarian National Bank (MNB): Virág, Barnabás (ed.), Long-term sustainable econo-mix, published by MNB, Budapest, page 465-483

- unbalanced growth of global population,
- climate change,
- decline of fossil energy sources,
- growth of green tax,
- robots and artificial intelligences, as new production factors,
- digitalisation of money,
- age of zero interests,
- dynamic development of the space sector and space industry.

The latter megatrend focuses mostly on technological development, technology changes, and thus, new industries of the future. A number of technological developments connected to the space industry as a prospective industry of the future, become part of everyday life more than ever.

In this respect, the opportunities and the role of the domestic space economy and space industry, are significant in the long term in the Hungarian economy, as a new area that increasingly determines future development, requiring cooperation between the state and private sector.

One of these promising themes is strengthening the multi-faceted connection and interdependence between sustainability and competitiveness. In connection with competitiveness, the emphasis on long-term improvement is needed by the fact that, according to experiences, often only the analysis of past and present processes comes to the fore, which proves unsatisfactory for the sustainable competitiveness improvement as the basis for sustainable development. In this respect, it is essential to multi-faceted take into account not only social capital, but also the whole national wealth, including preservation of national wealth in terms of economic effects of climate change.

Another important determining field in the space sector is the promotion of ecological sustainability and green growth. Hereby, the extent and manner of exploitation of Earth and soil can be better explored from biodiversity through ecosystem (i.e. erosions, floods), quality of water and air to greenhouse gas emission.

It also has a considerable importance that, according to the megatrends affecting the financial system, the role of financial system in sustainable development, and thus, the safety of continuous financing of sustainable goals, including space sector and space industry goals, are transforming and increasing. This is also facilitated by the promising new financial approach in terms of social and environmental aspects, the spread of Environmental, Social and Governance (ESG) complex approaches. The space sector also makes an important contribution to sustainability by setting a forward-looking example for appreciating future capabilities such as complex problem-solving, critical analytical mind, innovative (cognitive) capability, artificial intelligence (AI), Internet of things (IoT), as well as Big Data analysis and their broad practical use. The role of Big Data is further enhanced by the fact that its application facilitates a more accurate measurement of sustainable development, especially if it is built on the national spatial data infrastructure integrated with the statistical information system.

Related measures

I.4.1 Promoting formation of a future-oriented economic structure
I.4.2 Improving economic competitiveness based on new technologies
I.4.3 Strengthening the economic potential of Hungary through increasing added value of space sector

2. Strategic goal: Strengthening Hungary's international role, broadening its connections, and creating organisational frames of coordination

Explanation

Strategic, long-term, consistent and targeted state activity is the basis for the prosperity of a knowledge-intensive space sector. Hungary has been part of the international professional network since the beginning of space activities, and a number of results are linked to its operation. Several outstanding achievements had an incentive, however uneven effect on the domestic space research. Until recently, Hungary's space industry did not even occupy its place in the world space industry that would have been justified by its relative development level achieved in the 1980's, while the development level of the Hungarian processing industry reaches the mainstream level in Europe.

The change in recent years can be observed since 2018 due to the increased governmental attention, including assignment of the space activities and space research to MFAT as an internationally recognised successful Hungarian administrative institution, and due to its active involvement in space activities and space research, and the success of some companies integrated into international relations. Even in recent years, the Hungarian level of state subsidies in the space sector has been significantly lagging behind countries with similar capabilities *(Chart 1)*, today, even though we can speak of a modest, but existing Hungarian space sector.

Increasing the level of awareness of Hungarian competences behind the achievements of the Hungarian space sector, contributes to a more efficient use of the potential in the sector. The better international visibility of the competences of the Hungarian space sector supports the integration into the international value chain and utilisation of the benefits from international knowledge transfer. In the interest of exploitation of high return on possibilities, strengthening Hungary's international position is expedient in four areas:

- Targeted strengthening Hungary's position in the ESA;
- Establishing a close strategic relationship with the new EUSPA organisation, increasing Hungary's ability to enforce its interests in the EU space political decision-making;
- Activities of diplomats at strategically important embassies;
- Promoting international knowledge transfer by increasing international visibility of Hungarian space competences.

In addition to state resources, companies consider it important to apply for EU funds.[31] A closer connection in the future between the Hungarian state and the global actors in the space sector can contribute to even a more successful involvement of the Hungarian space industrial actors in EU projects. In addition to the enhanced enforcement of interests in the EU, strengthening Hungary's space diplomatic connections can be ensured by professional diplomatic representation at the strategically important Hungarian embassies, alongside the Hungarian space policy interests towards both state and certain foreign actors.

[31] Companies participating in both the 2020 and 2021 HCCI surveys esteem EU funding as the second most important, in addition to public and in-house resources, and expect the role of EU funding to increase over the next 10 years.

Expanding Hungary's diplomatic positions cannot be achieved without creating increasing possibilities for Hungarian space companies to join ESA projects.

The growing rate of Hungary's payments to the ESA provides a good basis for this (by 2021, Hungary's contribution to the ESA budget has reached EUR 16.8 million). This is also of great importance, because the companies of the paying country, that is the domestic companies, benefit from the higher membership payments. Supported companies make a more intensive and growing participation in ESA possible, which will pay for itself in parallel with Hungary's higher ESA payments. Payments are allocated according to the geo-return principle (geographical return), i.e. companies in the space sector of the paying country, and their research institutions receive from the membership payments after deducting ESA organisational and infrastructural internal costs. For the paying Member State, obtaining space heritage facilitates the market entry for companies, the increase in prestige of research institutions and universities, the increase in competitiveness, and maintaining quality training opportunities for the new generations of professionals and retaining teaching staff. [32]

Practically, all the developed national economies of the world feel the urge to take advantage of the opportunities provided by new perspectives and to become involved in value creation.

Today, more than 80 countries have space programmes, and 17 out of 22 ESA Member States have specific acquis for space activities falling within its jurisdiction. This segment of the world economy is dynamically expanding, the trend of accession is accelerated.

Specific competition prevails: omission may cause the socio-economic detachment of a country, while successful accession may contribute to lasting catching up. [33]

For this reason, the Strategy considers very important the creation of the Hungarian legal system (Hungarian Space Law) and institutional context (Coordinating Authority) that substantially establishes the efficient and successful performance of the coordination and targeted economic development tasks of the state.

2.1 Specific goal: Supporting Hungarian space activities through central coordination background and complex national communication

Explanation

For the establishment of an effective legal and institutional background for the Hungarian space sector, it is essential to create a predictable and supportive regulatory environment (Hungarian Space Law) at the national level as soon as possible, in accordance with international obligations. At the same time, the active participation of the state is necessary worldwide in the interests of national defence, national security and the maintenance of sovereign communication.

In order to develop the industry, the effectiveness of communication and cooperation between actors can be improved by deepening the currently low level of coordination, which can create a synergic relationship that mutually strengthens each other's activities. Therefore, there is a need in Hungary

[32] Ferencz, Orsolya (2020): Az űrszektor gazdasági-társadalmi szerepe gazdaságtörténeti visszatekintésben és az állami szerepvállalás tükrében, In: Parragh, Bianka – Kis, Norbert (2020): Az ösztönző állam válságkezelése, Ludovika Egyetemi Kiadó (Ludovika University Publisher), Budapest, 2020

[33] OECD (2011): The Space Economy at a Glance, https://www.oecd-ilibrary.org/docserver/9789264111790-en.pdf?expires=1612715921&id=id&accname=guest&checksum=A0DC5A6004615983A4D4B7463B13E2EA

for the establishment of a competent, central coordinating body that would also carry out propagative tasks in cooperation with the education sector. It may have another task to operate the system of tenders related to domestic resources, and to have a representation in international organisations.

There is a need for the identification of the international legal environment related to national space law and the best practices of the 22 ESA Member States. The elaboration of a system of rules at the national level (licensing, supervision, registration) of commercial space activities falling within the Hungarian jurisdiction is justified not only by our international legal obligation, but it is also required by Hungary's national economic interest. The creation of a national space market prospering in the course of legislation, promoting commercial space activities, but considering the state interests, is of key importance. The "national space law" forms part of the law and order in 35 states around the world. 17 out of 22 Member States of the European Space Agency have a special legal order regarding space activities falling within its jurisdiction.

With regards to the dangers and high risks of space activities, during legislation it should be ensured that only those objects can be launched into space that meet the strict safety standards, which also reduces the possibility of the formation of space debris.[34] It is in the interest of the state to strictly control private companies in terms of what their aim is regarding space activities and to ensure they fall within state jurisdiction. Moreover, it must be assured that space activities do not endanger national security interests.

For the implementation of the Strategy, it is essential to lay down the appropriate legal bases, which means the formation of the regulatory environment at legislation and decree level, taking into consideration the sectoral circumstances. It includes the regulation of industrial, research and educational fields, as well as the establishment of an extensive coordination organisation and institutional background covering the relevant space segments for the efficient development of the space sector, and the foundation of cooperation between the market actors.

In order to successfully develop space sector, it is essential to draw attention to the expansion of knowledge related to the space sector in the society (e.g. contribution of space sector to the quality of life in the society), and to the opportunities provided by the space sector for the professional audience (e.g. potential of return, attainable benefit).

With conscious, consistent and proactive state and market communication and a unified policy image, the public and professional support of the space sector can be significantly increased.

Related measures

2.1.1 Building the structure of domestic regulatory, organisational framework and financial incentive system for space activities, creating the legal harmonisation in the EU
2.1.2 Elaborating and operating an accreditation and monitoring system
2.1.3 Awareness raising, building of knowledge dissemination and support

[34] Bartóki-Gönczy, Balázs (2020): Az űrtevékenységek nemzeti szintű szabályozása, Iustum Aequum Salutare, XVI. 2020, Volume 4, page 93–114

2.2 Specific goal: *Strengthening Hungary's diplomatic positions, increasing abilities to enforce its interests*

Explanation

Interdisciplinary space activities everywhere in the world are implemented through intensive international collaborations. In recent years, significant progress has been made in the field of strengthening Hungary's diplomatic relations, as a result of which, a number of new opportunities have been opened for the actors of the Hungarian space sector through signing various Memorandums of Understanding. International partnerships, international corporate collaborations and emerging bilateral and multilateral diplomatic relations broaden the joining opportunities to the global space industry value chain and bring it closer for the domestic corporate and scientific sphere. Therefore, the Hungarian economic actors, whose presence in the strong international competition was not visible at times, can now strengthen their international visibility and activity in order to open new opportunities for business and industrial relations. As a result of cooperation among the Hungarian space researchers, industrial actors and diplomatic corps, with the active support of the diplomatic network of the ministry responsible for international relations and trade activities, six bilateral memoranda of understanding have been already signed with partner countries.[35]

Telecommunication, navigation and defence capabilities are all based on satellite technologies. Only those countries have and will have diplomatic, political and economic impact on several space and defence industrial issues that are able and willing to develop their space capabilities in due time. The others can only accept the conditions, some of which are forced on them, showcasing also the strengthening role of global multinational companies.

Further strengthening Hungary's diplomatic relations in the space sector is a matter of strategic importance, as it promotes the joining of Hungarian companies into the global value chain.

The existence of space capabilities is also a critical need in terms of sovereignty. It is characteristic of the European region that although several collaborations have been established between the countries, the infrastructure is characteristically national, and it is operated under the supervision of certain participating countries.

The ESA delegation, and thus the task force delegates should function as a connecting link between ESA and the domestic corporate sector. Since Hungary's accession, the system of delegates was only partially set up, therefore interests of Hungarian space policy and space industry can only partially prevail.

Due to the growth of the European Union's space policy efforts and role, it is important for Hungary to take a strong position in the region, therefore allowing Hungarian industrial actors to get involved in major EU projects.

In November 2020, the EU Member States approved the Council's conclusions defining principles of the global space economy. Several budget plans of the European Union offer considerable funding for supporting space industrial innovation in the individual Member States. Horizon Europe continues in the period 2021-2027, and Hungarian diplomacy also takes a more active role in the planning of its space industrial framework programme and tenders. The European Commission has announced an

[35] Bilateral partnership statements: in 2019 with the Federative Republic of Brazil and the Republic of Turkey, in 2020 with the Singapore Space & Technology Ltd., Israel, the French Space Agency, the Portuguese Republic and the US-based Virgin Galactic Holding.

additional totalling EUR 1 billion initiative called CASSINI (Competitive Space Start-ups for Innovation) to boost European space companies in the budget period 2021-2027, and in 2020, the European Investment Fund has also launched a placement of capital programme under the name of InnovFin Space Equity Pilot, in order to expand the funds of space industry in the Member States.

Related measures

2.2.1 Strengthening regional role (Establishment of V4 Space Cooperation)
2.2.2 Security policy role, strengthening capabilities and national integrity (EU, UN, NATO space defence)
2.2.3 Strengthening the role of Hungarian diplomacy in ESA/EUSPA

2.3 Specific goal: *Fostering our role in international programmes*

Explanation

By increasing international visibility of competences of the Hungarian space sector, joining in the international value chain, therefore, the efficiency of international knowledge transfer can be improved. Currently, less than 5 percent of the space companies participate in internationally relevant forums. Due to the limited resources (financial, human) of the market actors, on their own, they can only attend international events restrictedly. Due to this, Hungarian industrial actors cannot utilise the learning opportunities arising from international knowledge transfer, and cannot develop their specific competences.

It supports the increase of social acceptance if the signed declarations of intent within the framework of bilateral and multilateral diplomatic relations and collaborations are also embodied in joint international projects in the field of education and research.

By creating international platforms, the international network of domestic companies can be strengthened, thus the participation rate in joint projects can be increased. Through involvement of experts from different countries, the creation of research and development collaborations will be possible, in which internationally relevant projects can be implemented with participation and guidance of Hungarian experts.

Following Hungary's accession to ESA, support for the start-up ecosystem has started in the Hungarian space sector within the framework of ESA BIC programme.[36] Based on the experiences of recent years, an effective restructuring of the ESA BIC programme is needed, which could be considered as a breakout point.

Within the framework of the ESA BIC-TTO (Technology Transfer Office) centre and the ESERO (ESA's Education Resource Office), new opportunities in the field of education are opened to increase public acceptance of the space sector. With the ESERO programme, secondary school students can be familiarised with space research and space activities through scientific subjects, in addition to expansion of knowledge and training of teachers.

[36] ESA BIC is the start-up programme of the European Space Agency, which aims to locate and support start-ups that are capable of developing useful innovations for the space industry, and funnelling them into space companies.

Related measures

2.3.1 Supporting the expansion of Hungary's role in international research programmes (multi- and bilateral)
2.3.2 Fostering international trainings, upskilling
2.3.3 Ensuring personal and material conditions for international relations
2.3.4 Reorganisation of ESA BIC-TTO centre and ESERO

3. Strategic goal: Development of knowledge-based social and economic conditions and infrastructural background that is essential for prosperity of the space sector

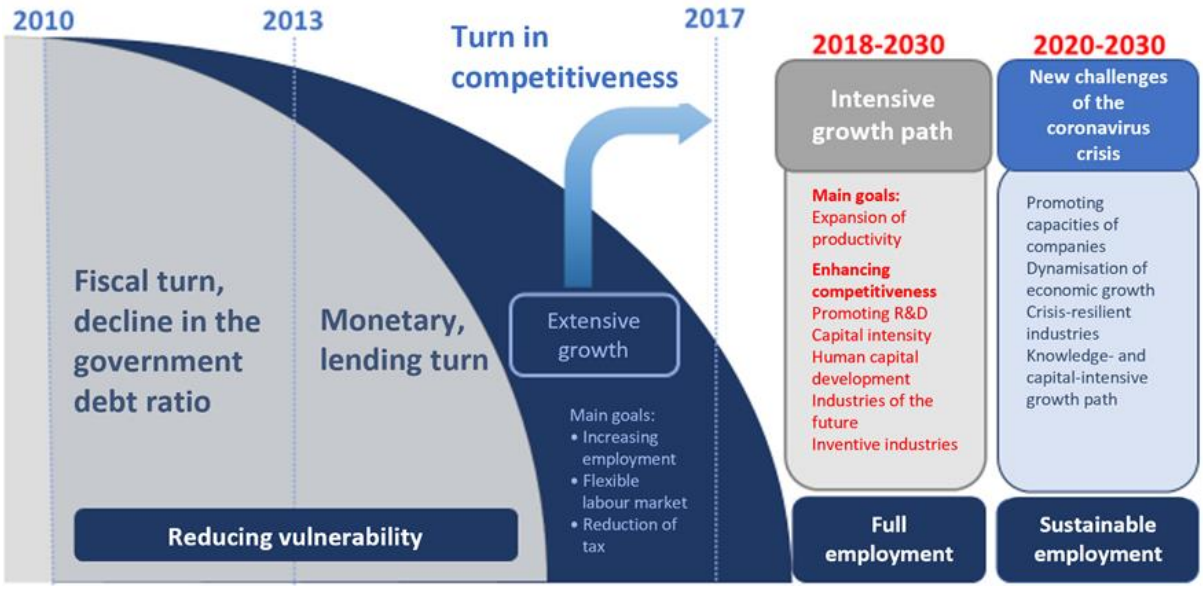
Explanation

Historically, the countries who have successfully implemented advanced economic catch up to advanced economies, were the ones who have built on knowledge capital. Looking back to the growth characteristics of the period 2010-2019, following successful fiscal and economic stabilisation, the opportunities for extensive growth narrow. A knowledge-, capital- and productivity-based growth path becomes necessary, of which the competitiveness turn is an important pillar that also marks a new level of knowledge- and technology-intensive development, and draws the attention to the key role of the space sector as an important resource for catching up and breaking out.[37] Today, investment in the knowledge-intensive industries of the future became a matter of economic strategic importance, focus of the governmental attention to these fields, especially to space sector, services and products based on space technology, thus digitalisation and artificial intelligence, etc. is key to sustainable development of the future that also supports the recovery from coronavirus pandemic of 2020 in earnest *(Chart 4)*. We need to use the achievements of technological development, digitalisation and artificial intelligence wisely in the interest of public goods, while turning the perspective of the industries of the future to the fullest advantage of the Hungarian economy.[38]

[37] The Hungarian National Bank pays special attention to the development of domestic economic growth and competitiveness, with special regard to the aspects of catching up with the European Union's advanced economies. Among other things in 2020, in the Competitiveness Report, and in 2020, in the Competitiveness Programme in 330 points publication of the Hungarian National Bank.

[38] Báger, Gusztáv – Parragh, Bianka (2020): The Coronavirus Crisis, Sustainable Development and the Incentive State Model, Public Finance, 2020/2 special edition

Chart 4: Main objectives and challenges for the 2010-2021 growth period



Source: UPS Economic Implications Research Team, 2020, supplemented with covid-19 crisis, according to MNB

The innovation-driven growth model provides a framework for the state approach aiming the shift towards a sustainable growth path based on knowledge, capital and productivity. To achieve this, the state's role to promote and develop is essential which aims at increasing R&D expenses and the number of professionals in R&D. Investing in knowledge- and technology-intensive and crisis-resilient industries[39] increases innovation capacity which also supports reaching the level of Visegrád countries and the EU average.[40]

The shift towards a knowledge-based society can be most effectively implemented in economies that are close to the state of full employment as a result of a workfare society. Based on the economic policy results for the period 2010-2019, Hungary fully complies with this requirement. Therefore, the Hungarian economy has the opportunity to move forward to qualitative improvements following the quantitative progress, while the balance indicators of the labour market can also be maintained.

In this respect, the space sector is of considerable importance, as the key of its current performance and future ambitious plans is ensured by the broad base of high-skilled professionals in the field of research and development. Referring also to the fact that in the first wave of the coronavirus pandemic in Hungary, the space sector was identified among the leading industries of the future in the Economy Protection Action Plan, which was created to reduce the negative economic effects of the pandemic.[41]

[39] Space sector produced close to EUR 300 billion in 2019 (approximately USD 400 billion), and the processes in 2020 also indicate progress even in the circumstances of covid-19 pandemic. The crisis-resilient capability of the space sector is proved by the following study: PWC (2020): Resilience of the Space Sector to the Covid-19 Crisis, In more details: https://www.pwc.fr/fr/assets/files/pdf/2020/05/fr-france-en-resilience-of-the-space-sector-to-the-covid-19-crisis.pdf

[40] According to the latest central bank report on our competitiveness, Hungary's innovation achievement lags behind the EU-average, however it is at an appropriate level to the regional average. The GDP-proportional R&D expenditures in Hungary between 2008 and 2018 increased from less than 1 percent to over 1.5 percent, 0.2 percent point above the performance of the other Visegrád countries that is encouraging. Nevertheless, the domestic target in 2020 was 1.8 percent, while the average in the EU was 2.1 percent. Hungarian National Bank (2020): Competitiveness Report.

[41] See Economy Protection Action Plan by the Hungarian Government, 7 April 2020, published in Hungarian Gazette, Volume 83, 22 April 2020
https://magyarkozlony.hu/dokumentumok/de50ed427205b037eac9c1f628e590180ed3e3c8/megtekintes

It is key for space companies to meet the needs of qualified professionals in the labour market, who are able to solve innovative and interdisciplinary challenges of industries in the 21st century. The current regional and domestic trends also show that without improvements, higher education cannot serve the growing demand for professionals that may significantly hinder the development of the space industry in the medium and long term.

Establishing cooperation across the entire life cycle of product development justifies a consistent and common project approach among the industrial and research actors, instead of ad hoc connections in the subfields.

High professional standards and the past of space activities are typical in higher education. Further development of internationally competitive, practice-oriented space training can be achieved by increasing the resources to be spent on educational purposes related to space activities, and by participating in domestic and international educational space projects. For this purpose, the higher education structure also needs to support practice-oriented, knowledge-transfer trainings that are essential to the space industry.

Although the space sector is attractive as a field, it is not as well known when it comes to career opportunities among Hungarian professionals and young graduates. Practice-oriented development of space education is needed for qualitative and quantitative growth of the Hungarian space sector.

3.1 Specific goal: Long-term foundation and acceleration of human resources developments

Explanation

In order to resolve short-term labour market challenges, and to ensure a fast and quality workforce opportunities, it is expedient to answer with short professional trainings, active participation in international educational opportunities, and popularising career opportunities. Continuous expansion of knowledge is possible through educating more engineers on a postgraduate level. This requires accredited space science and space engineering training in existing workshops, thus fostering project implementation with start-up companies. Support for projects is reasonable, in which research centres, universities and companies participate together. Thus, by becoming familiar with the market approach, management and project attitudes can be acquired, and proactive skills can be developed, which are essential elements of a long-term research career. Eliminating the lack of other competences related to space activities is also a priority (i.e. professional economist, professional lawyer). In addition, one of the basic conditions is to support stable operation and predictable financing of research centres, and to elaborate a forward-looking research programme.

All subsystems of the educational system are affected by development of the individual skills. Social acceptance and the knowledge of society can be improved through appropriate training systems in order to exploit the potential in the space sector.

Extensive information and training of potential Earth Observation Information System and Earth Observation Operative Centre (FIR-FOK) users and administrative actors through courses and workshops would result in cost savings at national economy level, and disseminating innovation through practical results and creation of a scientific innovation platform, presenting “good practices”, and facilitating strengthening international relations of actors.

A number of highly qualified professionals with multidisciplinary knowledge, extensive project experience and connections work in domestic research sites, exposed to international (wage)competition. In this respect, it is also key to stop brain drain and to elaborate a researcher career model.

As one third of the research institutes do not have either market experience or cooperation with industrial companies, as a result they do not bring their research results to the market either. Appropriate coordination, supporting and regulatory systems would facilitate effective cooperation between each other, and the exploitation of synergies with related sectors.

Through the operation of universities on the basis of a competence centre, the coordinated use of research infrastructure, complex research can be carried out that would increase the economic return on diverse domestic space research. Settled research programmes, strengthening of knowledge triangle (education, research and innovation) can improve the market approach, proficiency and motivation of research institutes, while ensuring high innovation potential with high utilisation rate.

Related measures

3.1.1. Introducing and maintaining secondary and higher education programmes, accredited space science and space engineer trainings with internships
3.1.2. Development of user capabilities related to space technology
3.1.3. Building interdisciplinary knowledge platform in space sector, dissemination of innovations
3.1.4. Creating a researcher career model

3.2 Specific goal: Improving the operational and infrastructural conditions of the institutional system

Explanation

Based on the existing and currently unfolding trends, it can be observed that among the criteria establishing the competitiveness of the space sector, the development of specific education is essential to ensure continuous, predictable knowledge of international standards. Therefore, higher state's involvement is needed in this field.

Increasing the options and interfaces of research institutes and education institutions in the space sector is determinant, which, due to their organisational and legal form, have limited or no access at all to tenders or applications for space industry financed by the ESA or other organisations, as they cannot get engaged in projects on a market basis.

Providing conditions and support for research institutes and educational institutions to freely establish and operate a spin-off company[42], and to establish investor relations, may increase the market utilisation of research results.

Through spin-off companies, research sites will have access to the opportunities that are already provided for the economic actors of the space industry, as tendering resources, international project

[42] Spin-off companies are technology-intensive small businesses set up by educational institutions or research institutes (publicly financed institutions) or their employees, one of the main objectives of which is the economic utilisation of research results.

tenders and involvement of capital also provide the opportunity to move forward. This is a long-term solution, and requires more substantial resources, though increasing the sovereignty of research sites.

Related measures

3.2.1 Performance-oriented development and support for the operational background of educational and research institutional system

3.2.2 Improving educational and research institute infrastructure, their technical and operational conditions

II.2 Examining coherence of the strategic goals

The chapter contains a comparative analysis that compares the spirit, main pillars and objectives of the current Strategy with principles and guidelines of more important, relevant international and domestic documents and strategies.

United Nations

Hungary has been a member of the UN Committee on the Peaceful Uses of Outer Space (COPUOS) since 1959, which supports peaceful utilisation and exploration of space and the use of space science and technology for sustainable economic and social development.[43] This intention is fully in line with the most important principles and priorities of Hungary's Space Strategy. The first among its strategic objectives, ***Utilisation of potential in the space sector to stimulate innovation and sustainable growth in the national economy as a whole***, is linked to the determination of the organisation not only to promote sustainable development through space, but also to ensure sustainability of space activities. This will foster international solutions to problems such as rapid growth of space debris. It is important to preserve the potential of space for future generations. Our country can contribute to this with the 2nd strategic goal: ***Strengthening Hungary's international role, broadening its connections, and creating organisational frames of coordination***. Our participation in COPUOS allows us to learn about international or national regulations concerning space activities. Besides, one of the most important arguments for our membership in COPUOS is that we have an opportunity to learn about space activities in 73 countries around the world and to meet and discuss cooperation possibilities with representatives of those nations, which expand their space activities. This requires continuous preparation that is served by the 3rd strategic goal: ***Development of knowledge-based social and economic conditions and infrastructural background that is essential for prosperity of the space sector.***

European Union

As part of the European Union's Space Strategy adopted in 2016, the EU is working on the so-called Space Programme Regulation for the period 2021-2027, on which the Council reached a preliminary political agreement with the European Parliament at the end of 2020. The Regulation entered into force in the first semester of 2021.

The 4 goals of the Strategy:

1. Maximising the benefits deriving from space activities for the society and EU economy
2. Fostering a globally competitive and innovative European space sector
3. Ensuring European autonomy in accessing and using space in a safe and secure environment
4. Strengthening Europe's global provider role and facilitating international collaborations

The basic pillars of Hungary's Space Strategy, like the EU's main objectives, include intentions for sustainable growth, competitiveness and knowledge-based, innovation development, efforts for self-reliance and international cooperation.

[43] http://www.unoosa.org/oosa/en/aboutus/roles-responsibilities.html

Hungary's goals and measures related to the **specific goals of EU Strategy**:

- **Fostering the use of space services and data** – ***1.3 Integration development of the space sector;***
- **Promoting EU's space programme and meeting new users' needs** – *1.2.3 Supporting pilot projects for market-oriented use of research data, promoting trade activity; 3.1.2 Developing user capabilities related to space technology;*
- **Fostering research and innovation, and development of skills** – ***1.1 Strengthening multiplicative effect of the Hungarian space sector;*** *1.1.1 Tender-based support for R&D groups and enterprises; 1.1.3 Promoting and supporting the establishment of spin-off firms;* ***1.2 Building targeted competences in the segments with high market potential;***
- **Fostering entrepreneurship and new business opportunities** – ***1.1 Strengthening multiplicative effect of the Hungarian space sector;*** *1.1.2 Tender-based encouragement of business collaborations;*

ESA

Starting point of the European Space Agency's Agenda 2025[44] strategic document, issued in April 2021 is that there is a need to intensify the development of space sector at European level, with regard to the current tendencies, including the growing commercialisation of space sector, strengthening of space competitors, especially the United States and China, and the capacities needed for reaction to challenges on the European continent (pandemic, economic difficulties, climate change). The document defines five priorities for the future.

1. Strengthening ESA-EU relations in order for ESA to become the de facto implementing agency of the EU space programme.

2. Strengthening market approach in the sector, at the same time support for energy efficiency, digitalisation and fast innovation.

3. Advancing safety and security issues related to space both in outer space (space weather forecast, dealing with space debris) and on our planet through Earth Observation (natural disaster prediction, support for border surveillance, migration flows).

4. Further developing ESA's priority programmes with special regard to launch vehicles and space-related services (telecommunications, satellite navigation, Earth Observation) and, in addition to existing space research programmes, the launch of new missions.

5. Completing the ESA transformation and strengthening organisational efficiency, in this context strengthening market approach, full-scale digitalisation of project management, and advancing aspects of diversity within the organisation and sustainability.

EU Partnership Agreement[45] (currently *in conciliation phase, not approved yet*)

This document presents the challenges and development priorities of the country for the period 2021-2027, and the conditions for successful and efficient inclusion of cohesion resources. Hungary's main goal until 2030 is to **increase economic and social competitiveness** while reducing territorial inequality.

The vision of Hungary's Space Strategy and all the three strategic goals serve the main objective of the Partnership Agreement. Furthermore, it is linked to the sixth strategic goal of the Ministry of Finance,

[44] https://download.esa.int/docs/ESA_Agenda_2025_final.pdf

[45] https://www.palyazat.gov.hu/tarsadalmi_egyeztetes_2021_2027

in which Hungary should become a country of **High-Tech, innovative and high added value production**, which aims to be facilitated by space activities, including the multiplier effect of the space industry. Concretely, 1.4 specific goal of the Space Strategy: ***Supporting sustainable development of the economy in the long term,*** and the measures under this goal are in line with the national objectives: *1.4.1 Promoting formation of a future-oriented economic structure; 1.4.2 Improving economic competitiveness based on new technologies; 1.4.3 Strengthening Hungary's economic potential through increasing added value of space sector.*

National Digitalisation Strategy (NDS) (2021-2030)

The overall aim of the Strategy, which is to be adopted by the government: **Hungary should make concerted action to promote digitalisation in the field of economy, education, research and development and innovation, public administration that make a significant contribution to improve competitiveness of the country and the well-being of its citizens, even by international standards**. Among its specific goals

- The creation of digital infrastructure serves realisation of two measures, *1.4.2 Improving economic competitiveness based on new technologies,* formulated in ***1.4 specific goal: Supporting sustainable development of the economy in the long term****,* and *3.2.2 Improving educational and research institute infrastructure, their technical and operational conditions,* formulated in ***3.2 specific goal: Improving the operational and infrastructural conditions of the institutional system****.*
- Among the specific goals of the Space Strategy, **development of digital skills** is in line with the measure *3.1.2 Developing user capabilities related to space technology,* formulated in ***3.1 specific goal: Long-term foundation and acceleration of human resources developments.***
- Increasing **digital preparedness of companies** and **integration** of digital technology is connected to the measure *1.1.4 Encouraging the shift towards a knowledge-based economy through knowledge and technology intensive investments,* within ***1.1 specific goal: Strengthening multiplicative effect of the Hungarian space sector.***
- The expansion of **digital public services** combines several intentions in a complex way that strengthen the motivation of citizens and businesses, and fulfil cross-border goals performing in line with the EU expectations, supporting efficiency of processes of public administration back-office through automatization and the creation of interoperable data link networks needed for data-based operation. One of the specific goals of Hungary's Space Strategy is the ***1.3 Integration development of the space sector,*** which has three measures linked to the specific goal of NDS: *1.3.1 Horizontal and vertical data harmonisation, increasing data processing capacities; 1.3.3 Incorporating data from space activities into a standardised system, establishing data centres; 1.3.4 Resolving barriers to data access, supporting open data platforms.*

Strategy for SMEs

In 2019 Hungary's Strategy for SMEs for the period 2019-2030 has been completed, which **aims to increase the added value, productivity and export capability of domestic SMEs**, reacting to challenges the country is facing, and thereby, **to increase the quality of life in Hungary**. In line with this, the goals of Hungary's Space Strategy have been created, out of which the three strategic goals

1. Exploiting potential of space sector stimulating innovation of national economy as a whole and sustainable growth;
2. Strengthening Hungary's international role, broadening its relations, and creating organisational frames of coordination;

3. Ensuring knowledge-based social and economic conditions, and infrastructural background that is essential for the prosperity of space sector

embody the intentions expressed by the goals set for SMEs.

Comprehensive goals of the Strategy for SMEs:

- **Ensuring predictable framework for operation of the entire SME sector;**
- **Strengthening value-creating capability of those companies that are able to significantly grow.**

Hungary's Research, Development and Innovation Strategy (2021-2030)

Comprehensive goal of the Strategy to be adopted by the government is to develop a governance, organisational and financing model for research and development and innovation in order to strengthen institutional capabilities and capacities of the so-called developer state for this purpose.

This allows:

● the integrated use of Research, Development and Innovation (RDI) funds, and their consistent concentrated management;
● the predictable and stable operation and financing of the RDI organisational system;
● strengthening collaborations;
● focusing on domestic RDI activities in order to increase efficiency and Hungary's competitiveness.

The RDI Strategy is in line with the goals of Hungary's Space Strategy in several respect:

● By creating a stable supportive environment, it contributes to achieving a vision and locating responses to major social challenges.
● It supports innovation for all organisations, not only technological innovation, but scientific and business excellence research and awareness raising, as well.
● It promotes the increase of international, especially European degree of integration.

The **National Smart Specialisation Strategy (S3)** forms a bridge between RDI Strategy and sectoral strategies, setting specialisation directions and sectoral technological priorities.

The National Smart Specialisation Strategy (S3) prioritises research and innovation, and promotion of the social-economic use of results deriving from this. The novelty of the Strategy is that it has created a certain focus by setting the national smart specialisation directions (national specialisations, national priorities, intelligent technologies).

Hungary's Artificial Intelligence Strategy (2020-2030)

The Strategy formulated in 2020, aims to use and **develop artificial intelligence together, responsibly, as a global partner to serve everyday lives of all of us**. Its scope consists of six **foundation pillars**, which the ***objectives*** and measures of the Space Strategy is in line with, as follows:

- **Starting data economy** (market-based trading of public data, free access to public data under EU legislation) – ***1.3 specific goal: Integration development of the space sector*** *– 1.3.4 Resolving barriers to data access, supporting open data platforms;*
- **Research and development, innovation, "we develop together"** (building research synergies, positioning technological developers, ecosystem-based cooperation on domestic and European basis in technological research and development) – ***1.1 specific goal: Strengthening multiplicative effect of the Hungarian space sector*** *– 1.1.1 Tender-based support for R&D groups and enterprises; 1.1.3 Promoting and supporting the establishment of spin-off firms; 1.1.2 Tender-based encouragement of business collaborations; –* ***1.2 specific goal: Building targeted competences in the segments with high market potential*** *– 1.2.1 Fostering incubation activities in space science and space engineering research and/or training sites; 1.2.2 Supporting development of industrial and production capacity;*
- **Promoting adaptations – „extensive adaptation"** (to inspire and support determined and tailor-made experiments in order to gradually integrate the already available and proven technologies) – ***1.2 specific goal: Building targeted competences in the segments with high market potential*** *– 1.2.3 Supporting pilot projects for market-oriented use of research data, promoting trade activity;*
- **Education, competence development and preparing the society – "human skills are in focus"** (to enable present and future societies to seize the opportunity and if it is needed, to place their own development on a new path) – ***3.1 specific goal: Long-term foundation and acceleration of human resources developments*** *– 3.1.1 Introducing and maintaining secondary and higher education programmes, accredited space science and space engineering trainings with internships; 3.1.2 Developing user capabilities related to space technology; 3.1.3 Building interdisciplinary knowledge platform in space sector, dissemination of innovations, integrated interconnections of university courses;*
- **Developing infrastructure – "stable and available infrastructure"** (to create digital infrastructure of the future that can form the basis for research and development efforts) – ***1.3 specific goal: Integration development of the space sector*** *– 1.3.1 Horizontal and vertical data harmonisation, increasing data processing capacities (BIG DATA, AI, IoT, FIR-FOK, connecting Earth-Space data); 1.3.2 Establishing internationally accredited test centre, standardised testing capacities; 1.3.3 Incorporating data from space activities into a standardised system, establishing data centres; –* ***3.2 specific goal: Improving the operational and infrastructural conditions of the institutional system*** *– 3.2.2. Improving educational and research institute infrastructure, their technical and operational conditions;*
- **Regulatory and ethical framework – "reliable, regulated use"** (to create regulatory and control framework for responsible, reliable and human-centred exploitation of the potential in technology) – ***2.1 specific goal: Supporting Hungarian space activities through central coordination and communication*** *– 2.1.1 Building the structure of domestic regulatory,* ***organisational framework*** *and financial incentive system for space activities, creating the legal harmonisation in the EU; 2.1.2 Elaborating and operating an accreditation and monitoring system; 2.1.3 Awareness raising, building knowledge dissemination and support.*

The Second Climate Change Strategy of Hungary[46] (NCCS-2)

The Strategy, adopted in 2018, *"includes the evaluation of potential effects of climate change in Hungary, the natural and socio-economic consequences, furthermore the climate vulnerability assessment of ecosystems and sectors, the goals for mitigation of greenhouse gas emissions by 2050, the National Decarbonisation Roadmap, which includes priorities and action directions, furthermore*

[46] https://nakfo.mbfsz.gov.hu/en/node/365

the Hungarian Adaptation Strategy. Main objective of the latter is to prevent the risks related to climate change and climate safety, mitigation of damages, and to present the scope for awareness-raising activities on climate change prevention, preparation for climate change and adaptation to it, and to define sectoral action directions in the field of human health, agriculture and rural development, water management, forestry, environmental protection, energetic infrastructure, tourism, urban development and disaster management." **Its main principle on climate policy that achieving sustainable development is the most important, through steadily ensuring the common good,** is in accordance with the vision of Space Strategy, according to which ***"With its multiplicative effect extending to more industries, and with the employment of qualified, highly educated workforce, space sector contributes to increasing competitiveness of Hungarian economy, thereby to the higher quality of life of the society, ultimately, to the common good."***

With the *1.3 specific goal: Integration development of the space sector,* Hungary's Space Strategy serves the implementation of NCCS-2 by enabling the forecasting of meteorological anomalies, agricultural and water management, territory use change and disaster management events, and modelling all of these, through the interconnection and evaluation of earth observation data and ground measuring systems.

"Foundation of the Geographical Information System for territorial examination of climate vulnerability: Territorial and sectoral strategic integration of adaptation to climate change requires extensive information on social, economic and environmental vulnerability to change. Based on domestic research and the results of Earth Observation, the aim is to ensure the continuous operation of a Geographical Information Data System suitable for multi-purpose use that provides the flexible decision-preparation, decision-making and planning adapting to variable circumstances, with objective information."

II.3 Risk factors arising at the implementation of the Strategy

Risk factor	Expected impact and result	Probability	Impact	Preventive / Corrective action
		Economic and financial risks		
G1 – Lack of funds	The lack of some key elements of complex planned programmes has effect on other areas (see the interaction among certain interventions).	**medium**	**high**	**The Strategy is implemented through intersectoral coordination and harmonisation of financing. Planning of complex programme packages.**
G2 – Lack / weakness of intersectoral collaborations	Elaboration of a supportive development system for promoting greater effectiveness of synergic effects is needed.	**medium**	**medium**	**Supporting networking of space companies and research workshops (through tenders). Promoting cooperation among enterprises.**
G3 – Unsuccessful joining in the value chain	During the creation of Hungarian regulatory system for space activities, it is necessary to pay greater attention to the acquisition of various standards and accreditation-related capabilities, thereby facilitating joining in the value chain.	**medium**	**medium – high**	**Harmonisation of the accreditation support system, the related application system, the EU legal environment and market standards. Supporting stable operation conditions of research institutes by ensuring supportive background infrastructure.**
G4 – Basic research is weakened by a more favourable alternative	As reflected in the appearance of market-oriented research directions, it is particularly important to pay attention to the safekeeping of research workshops dealing with basic research on space activities.	**high**	**medium**	**On the one hand, it is important to dissociate cooperation between the spin-off company and the research institution, both in terms of task- and resource-allocation, on the other hand, creation and strengthening of indicators and incentives is needed for sustaining basic research.**
G5 – Resource allocation related to political cycles	Space research typically tends to manifest itself in long-term project cycles, especially in case of projects implemented in international cooperation. It is necessary to take it into consideration during actual budget planning of the territory.	**high**	**medium**	**It is practical to provide sources in the budget in a rolling way.**
		Legal, institutional risks		
J1 – Contradiction among domestic space actors, sector-specific conflicts are not resolved	In the Hungarian space sector, historically serious conflicts are present. Despite the professional forums and transparency, these sector-specific conflicts persist.	**high**	**medium**	**Improving the self-organising ability is key, in which HCCI plays a generative role facilitating cooperation and partnership. Mediation role of the central coordination body, continuous contact with participants, precise definition and interpretation of cooperation rules along with common goals, more**

Risk factor	Expected impact and result	Probability	Impact	Preventive / Corrective action
				systematic information sharing and consultation within the Ministry and authorities.
J2 – Market operational competence of the research sphere is incomplete	Market operation requires significantly different competences from the research sector that are necessary for successful sales of the products.	**medium**	**medium**	**Preparing competence development assessment within the framework of consultation on establishing a business. Promoting and supporting formation of spin-off companies. Supporting pilot projects demonstrating market-oriented use of research data, promoting commercial activities.**
J3 – Willingness, availability and preparedness of actors is low in the stage of implementation	Willingness to provide information and sectoral cooperation on the part of the actors is low, or rather they do not have a comprehensive database themselves.	**medium**	**medium**	**By drawing of domestic funds, establishing terms and conditions to encourage cooperation.**
J4 – Partial legal harmonisation	In the absence of time or human resources, the full legal harmonisation cannot be achieved, the desired effect fails to happen.	**low**	**medium**	**Resources should be provided for the full harmonisation, involving the organisations concerned.**
J5 – Lack of tender infrastructure for supporting international participation	Education institutions do not have adequate financial guarantee or human resources capacities in terms of the ESA educational projects and pilot opportunities.	**medium**	**high**	**Securing financial resources that can cover application assistance and international participation, predictably and in the long term.**
J6 – Uncertainties in the delimitation of competences and authorities	A clear set of criteria and a straightforward legislative environment foster access to space activities for market and state actors. During its creation, particular attention should be taken to ensure the capacity of the National Media and Infocommunications Authority (NMHH), organisations and ministries supervising the sectors relying on services of other space objects, so that the activities of the MFAT, which supervises the operation of space activities, are not compromised.	**medium**	**high**	**Conducting extensive professional and policy consultations during the necessary codification. It is important to take into consideration the practical experiences of already existing international regulatory examples.**
Social risks				
T1 – Lack of social acceptance	Acceptance of space sector in the Hungarian society is low, citizens are not aware of the everyday benefits and significance of space activities.	**medium**	**medium**	**Popularisation of the space sector, launch of various information campaigns to call attention to importance of the sector. A competency catalogue**

Risk factor	Expected impact and result	Probability	Impact	Preventive / Corrective action
				that collects Hungarian skills and achievements so far.
T2 – Low participation willingness on the part of the students, or rather the educational targets and career opportunities are not clarified	An important goal is to make the training and long-term career opportunities offered by the Hungarian space sector widely known to university students.	**high**	**medium**	**Developing appropriate incentives, and a background institution's coordinating and popularisation activities, creating a career path in space sector.**
T3 – The utilisation of FIR-FOK system may remain low	Despite the fact that the system works, the actors do not take advantage of its potential, as they do not know what problems it may be useful to solve.	**low**	**medium**	**The products have been developed in close collaboration with public authorities, therefore it has to be shown how the data can be used for a specific problem. Unravelling of data access barriers, supporting open data platforms.**
Potential risks of international collaborations				
N1 –The political and economic interests in case of space collaborations are not necessarily the same	Excessive emphasis on economic interests can damage Hungary's allied relations and security policy interests, at the same time if Hungary cooperates exclusively with the allies, the Hungarian space industry may lose access to serious international possibilities, an excessive dependence on certain partners may develop.	**medium**	**medium**	**As a member of the NATO and the EU, the national economic interests in space cooperation should be primarily interpreted in security policy aspects, but exploring the possibility of peaceful space research and space industrial cooperation with traditional and emerging space nations outside the NATO and the EU has to be continued.**

II.4 Method and follow-up of the implementation of the Strategy

II.4.1 Institutional conditions to achieve the goals

Evaluation of the current professional management situation, determining further institutional developments

The management and coordination of national space research and space activities is an extremely complex task, as it involves a large number of sectors. Interdisciplinarity of the field is the reason why, differently to other sectors, countries establish separate organisational units, organisations for the tasks specifically related to space activities.

Complexity of the area is demonstrated by the fact that practically all services or research requiring objects in space are qualified as space activities. And this concerns a number of fields and special policies. It is not fully under the control of any policy, and requires permanent coordination with other ministries and organisations.

The supervision of the Ministry of Foreign Affairs and Trade has a number of advantageous institutional conditions. MFAT (and the diplomatic corps) is at the forefront of articulating several special fields (economy, security policy, export development, etc.) along national interests. Thus, it is especially useful that the sector, which can be operated through a wide international network, closely cooperating with multilateral organisations, is under the policy control of that ministry, which itself has international network of contacts and knowledge through operating our country's diplomatic network and maintaining its international relations.

Based on the management experiences, it was internationally positively received that Hungary's space activities fall within MFAT's competence since 2018. Moreover, several of the international partners are interested in the experiences of the form, as space research and space activities are effectively aided by the established forms and agreements in diplomacy. These positive effects are mutual, as Hungarian diplomats have also been given a new, marketable opportunity to expand the country's international relations. Rightness of the Hungarian way since 2018 is shown by the fact that in terms of space research, international partners have also started to use the contact and agreement forms used by the Ministry of Foreign Affairs and Trade, which had no precedent previously.

Based on the positive experiences it can be stated that the policy management of the Hungarian foreign policy has such capabilities, on which it is worth building during creating institutions of Hungarian space research and space activities.

The most typical institutionalisation form in the world, in Europe definitely, is the agency form that is the space agency. The institution provides opportunities to carry out governmental tasks while making the field clear and visible. Facilitating single-channel communication brings a number of reliefs to both domestic and foreign partners.

The long-term importance of financing the sector is known, and a dedicated organisation is more effectively able to interpret important aspects of the field.

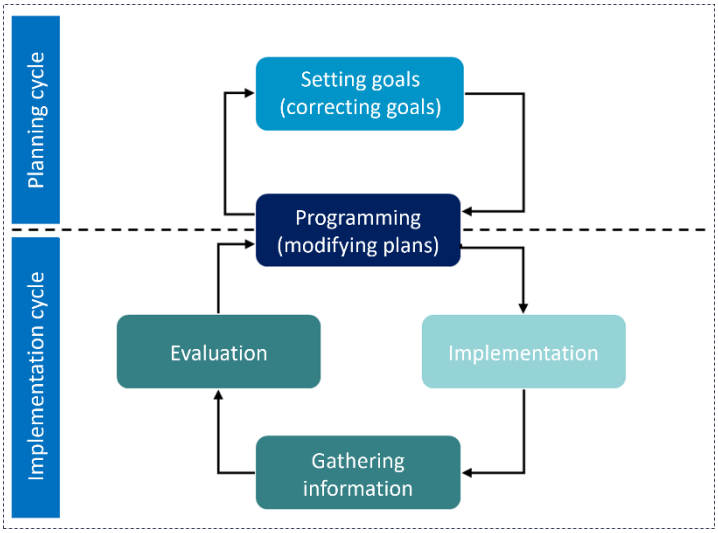
In the field of international relations, it is possible to create a governmental level that can be easily identified by the international partners, as well.

II.4.2 Establishment of the monitoring system

Planning of the Strategy is based on a number of assumptions that appear to be correct and well-founded with the information currently available, and thus, for a reason, objectives and measures to achieve them can be built on them. However, due to ongoing changes in the external and internal environment (allocation of resources in 2021-2027, finalisation of operational programmes, internal regulatory, economic environment, etc.), achievement of the goals and creation of the expected results and impacts cannot be considered automatic.

Therefore, successful implementation of the Strategy is inconceivable without a feedback mechanism that allows us to intervene again and again at all points in the strategy-making process, making the necessary corrections. This feedback is ensured by the monitoring system. From this logic, it follows that the monitoring system is primarily a tool for the strategic management in controlling the implementation that fulfils its function, if it is operated continuously (*Chart 5*).

Chart 5 ***Feedback based on the monitoring***



Due to its specific character, data submission is in a number of cases linked to data collection related to governmental activities. Therefore, during designing the organisational and operational system, it is necessary to determine the content of the database, and the scope of obligation to provide information.

The frequency of data collection and measurements should be fixed to the cyclicity of revision of the Strategy that has to happen according to the EU funding periods (7 years), with the inclusion of a survey and evaluation allowing for intermediate / half time correction (3-4 years), however, with regard to the turbulent environmental changes and recovery and reconditioning period due to covid-19 crisis, review is recommended at least every two years.

In order to determine whether the implementation of the Strategy is moving in the right direction and at a good pace, and to examine whether the strategic goals are still valid a few years later, developing a complex evaluation system is needed. The evaluation system to be developed will be suitable for carrying out the evaluation as reflected in realised public expenditure in the period up to 2030. Setting 31 December 2022 as the deadline for the completion of this task is realistic.

Indicators for the scope of the Strategy – Determining measures omitted from short-term action plan:

SPECIFIC GOALS	MEASURES	NAME OF THE INDICATOR, ITS DEFINITION AND EXPECTED CHANGE	UNIT	SOURCE / MEASUREMENT METHOD	FREQUENCY OF MEASUREMENT (year)
1.1 Strengthening multiplicative effect of the Hungarian space sector	1.1.1 Tender-based support for R&D groups and enterprises	Number of applicants, increase	person	MFAT database	yearly
		Market-based sale of developments, increase	million HUF	Ministry of Finance, HCSO	yearly
		Number of professionals, employees in R&D, increase	person	HCSO	yearly
		Number of subsidized applications, increase	number	MFAT database	yearly
		Number of accredited actors, increase	number	MFAT database	3-4
		Number of project level international collaborations, increase	number	MFAT database	3-4
	1.1.2 Tender-based encouragement of business collaborations	Number of subsidized enterprises, increase	number	MFAT database	3-4
		Number of project level collaborations, increase	number	MFAT database	3-4
1.2 Building targeted competences in the segments with high market potential	1.2.1 Fostering incubation activities in space science and space engineering research and/or training sites	Number of participants in incubation, increase	number	MFAT database	3-4
		Market entry ratio, increase	%	MFAT database	3-4
	1.2.2 Supporting development of industrial and production capacity				
	1.2.3 Supporting pilot projects for market-oriented use of research data, promoting trade activity	Increase of TRL during R&D	level	MFAT database	3-4
	1.2.4 State promotion and support for developing competences that enhances the efficiency of corporate management and strengthens the management approach	Export sales revenue	million HUF	HCSO	yearly
1.3 Integration development of the space sector	1.3.1 Horizontal and vertical data harmonisation, increasing data processing capacities	Data communications ratio	%	HCSO	yearly

SPECIFIC GOALS	MEASURES	NAME OF THE INDICATOR, ITS DEFINITION AND EXPECTED CHANGE	UNIT	SOURCE / MEASUREMENT METHOD	FREQUENCY OF MEASUREMENT (year)
	1.3.2 Establishing internationally accredited test centre, standardising testing capacities	Related information developments	million HUF	ITM	3-4
		Number and rate of databases connected to the network, increase	number, %	Reports of universities and research sites	yearly
		Number of research sites involved, increase	number	MFAT data submission	3-4
		Number of studies, strategies, evaluations inspired by the possibilities of integrated database	number	MFAT data submission	3-4
		Number of international project proposals based on market-oriented data utilisation, increase	number	Reports of universities and research sites	yearly
	1.3.3 Incorporating data from space activities into a standardised system, establishing data centres	Number and rate of databases connected to the network, increase	number, %	Reports of universities and research sites	yearly
		Number of research sites involved, increase	number	MFAT data submission	3-4
		Number of studies, strategies, evaluations inspired by the possibilities of integrated database	number	MFAT data submission	3-4
		Number of international project proposals based on market-oriented data utilisation, increase	number	Reports of universities and research sites	yearly
1.4 Supporting sustainable development of the economy in the long term					
2.1 Supporting Hungarian space activities through central coordination and communication	2.1.1 Building the structure of domestic regulatory, organisational framework and financial incentive system for space activities, creating the legal harmonisation in the EU	Number of legal provisions, increase	number	MFAT data submission	3-4
		Number of EU space / strategic documents prepared with Hungarian participation, increase	number	MFAT data submission	3-4

SPECIFIC GOALS	MEASURES	NAME OF THE INDICATOR, ITS DEFINITION AND EXPECTED CHANGE	UNIT	SOURCE / MEASUREMENT METHOD	FREQUENCY OF MEASUREMENT (year)
		Number of sectoral statutes involved in space activities, increase	number	MFAT data submission	3-4
		Number of accredited enterprises, organisations, increase	number	MFAT data submission	3-4
	2.1.2 Elaborating and operating an accreditation and monitoring system	Number of subsidized enterprises, increase	number	MFAT data submission	yearly
		Number of companies with an international standard, increase	number	MFAT data submission	3-4
	2.1.3 Awareness raising, building knowledge dissemination and support	Number of strategic partnerships, increase	number	MFAT data submission	yearly
2.2 Strengthening Hungary's diplomatic positions, increasing abilities to enforce its interests	2.2.3 Strengthening the role of Hungarian diplomacy in ESA/EUSPA	Tendency in the number of diplomatic staff seconded to the ESA and EUSPA, and seconded national experts, will not decrease	person	MFAT data submission	3-4
		Number of contracted experts, increase	person	MFAT data submission	3-4
		Proportion of participation in optional programmes in relation to compulsory payments, increase	number / million HUF	MFAT data submission	3-4
		Participation rate in successful EU space tenders, increase	%	MFAT data submission	3-4
		Visits to websites containing calls for proposals, increase	person	MFAT data submission	yearly
2.3 Fostering our role in international programmes	2.3.3 Ensuring personal and material conditions for international relations	Number of international projects with Hungarian participation, increase	number	MFAT data submission	yearly
		Number of Hungarian co-exhibitors, increase	number	MFAT data submission	yearly
		Number of events in Hungary, increase	number	MFAT data submission	yearly
		Participation of domestic research-industrial actors in foreign	number	MFAT data submission	yearly

SPECIFIC GOALS	MEASURES	NAME OF THE INDICATOR, ITS DEFINITION AND EXPECTED CHANGE	UNIT	SOURCE / MEASUREMENT METHOD	FREQUENCY OF MEASUREMENT (year)
		conferences, fairs and forums, increase			
		Number of Hungarian presentations in foreign events, increase	number	MFAT data submission	yearly
	2.3.4 Reorganisation of ESA BIC-TTO centre and ESERO	Number of space industry/service start-ups operating in incubation, increase	number	MFAT data submission	3-4
		Number of start-up centres, increase	number	MFAT data submission	3-4
		Promoting domestic incubation, amount of own funds, increase	million HUF	MFAT data submission	yearly
		The amount of relevant venture capital increases	million HUF	MFAT data submission	yearly
		Rate of economically independent start-ups, increase	%	MFAT data submission	yearly
3.1 Long-term foundation and acceleration of human resources developments	3.1.1 Introducing and maintaining secondary and higher education programmes, accredited space science and space engineering trainings with internships	Number of STEAM graduates, increase	person	Universities	3-4
		Relevant PISA results of secondary education institutions / their ranking, improvement	ranking	ITM	3
		Number of university lecturers, increase	person	Universities	yearly
		Number of employees in domestic space sector, increase (incl. follow-up)	person	MFAT	yearly
		Number of students involved in national projects, increase	person	Universities, MFAT	yearly
		Number of participants in doctoral education, increase	person	Universities, MFAT	3-4
		Number of participants in post-graduate trainings, increase	person	Universities, MFAT	3-4
	3.1.2 Developing user capabilities related to space technology	Number of market actors using space technology, increase	number	MFAT data submission	3-4

SPECIFIC GOALS	MEASURES	NAME OF THE INDICATOR, ITS DEFINITION AND EXPECTED CHANGE	UNIT	SOURCE / MEASUREMENT METHOD	FREQUENCY OF MEASUREMENT (year)
		Number of new, high value-added, innovative products and services, increase	number	MFAT data submission	3-4
3.2 Improving the operational and infrastructural conditions of the institutional system					

III. SHORT-TERM STRATEGIC ACTION PLAN

III.1 Short-term measures and interventions serving the achievement of the strategic goals

The long-term scope should be further broken down into a short-term period of 1-5 years, as a result, not all measures are prioritised in the first step. In order to achieve the goals as far as possible, and to best serve the basis for their fulfilment, a complex set of measures in its context had to be selected that can be implemented with the strongest synergy in this period.

These are the following measures (highlighted in blue, in italics):

Specific goal	Measures
1.1 Strengthening multiplicative effect of the Hungarian space sector	*1.1.1 Tender-based support for R&D groups and enterprises*
	1.1.2 Tender-based encouragement of business collaborations
	1.1.3 Promoting and supporting the establishment of spin-off firms
	1.1.4 Encouraging the shift towards a knowledge-based economy through knowledge and technology intense investments
1.2 Building targeted competences in the segments with high market potential	*1.2.1 Fostering incubation activities in space science and space engineering research and/or training sites*
	1.2.2 Supporting development of industrial and production capacity
	1.2.3 Supporting pilot projects for market-oriented use of research data, promoting trade activity
	1.2.4 State promotion and support for developing competences that enhances the efficiency of corporate management and strengthens the management approach
1.3 Integration development of the space sector	*1.3.1 Horizontal and vertical data harmonisation, increasing data processing capacities*
	1.3.2 Establishing internationally accredited test centre, standardising testing capacities
	1.3.3 Incorporating data from space activities into a standardised system, establishing data centres
	1.3.4 Resolving barriers to data access, supporting open data platforms
1.4 Supporting sustainable development of the economy in the long term	1.4.1 Promoting formation of a future-oriented economic structure
	1.4.2 Improving economic competitiveness based on new technologies
	1.4.3 Strengthening Hungary's economic potential through increasing added value of space sector
2.1 Supporting Hungarian space activities through central coordination and communication	*2.1.1 Building the structure of domestic regulatory, organisational framework and financial incentive system for space activities, creating the legal harmonisation in the EU*
	2.1.2 Elaborating and operating an accreditation and monitoring system
	2.1.3 Awareness raising, building knowledge dissemination and support

Specific goal	Measures
	2.1.4 Launch of flagship projects (Hungarian research astronaut mission, individual satellite programme, Radiation Effects Testing Laboratory)
2.2 Strengthening Hungary's diplomatic positions, increasing abilities to enforce its interests	2.2.1 Strengthening regional role (Establishment of V4 Space Cooperation)
	2.2.2 Security policy role, strengthening capabilities and national integrity
	2.2.3 Strengthening the role of Hungarian diplomacy in ESA/EUSPA
2.3 Fostering our role in international programmes	2.3.1 Supporting the expansion of Hungary's role in international research programmes
	2.3.2 Fostering international trainings, upskilling
	2.3.3 Ensuring personal and material conditions for international relations
	2.3.4 Reorganisation of ESA BIC-TTO centre and ESERO
3.1 Long-term foundation and acceleration of human resources developments	*3.1.1 Introducing and maintaining secondary and higher education programmes, accredited space science and space engineering trainings with internships*
	3.1.2 Developing user capabilities related to space technology
	3.1.3 Building interdisciplinary knowledge platform in space sector, dissemination of innovations, integrated interconnections of university courses
	3.1.4 Creating a researcher career model
3.2 Improving the operational and infrastructural conditions of the institutional system	3.2.1 Performance-oriented development and support for the operational background of educational and research institutional system
	3.2.2 Improving educational and research institute infrastructure, their technical and operational conditions

The most important measures embrace key areas that have the widest impact on multiplicative effect of domestic space activities, and they are capable of displacing development from its current state. The domestic backlog of space industry can be defined along the following sub-areas, which solution and support is the most urgent:

- lack of professionals in each sector,
- isolated operation of knowledge triangle (education, research and innovation), knowledge transfer,
- lack of domestic organisational, operational and support framework,
- underutilisation of international representative, cooperative potential,
- dependence / exposition issues.

1.1 Specific goal: Strengthening multiplicative effect of the Hungarian space sector

Measure	**1.1.1 Tender-based support for R&D groups and enterprises**
Overall objectives	● Creating engaging and predictable environment for R&D groups ● Creating performance-based financial opportunities ● Hungarian-owned intellectual property ● Elaboration of RDI tenders providing the possibility to support RDI activities related to space economy, space industry and space research
Justification for its necessity	The most important condition necessary for the functioning of research trends in domestic space sector is to have predictable and professionally appropriate tenders available for the continuation of their activities. It is also necessary to mention the importance of that, if performance-based research is formulated as a goal, we cannot ignore the fact this source secures for the state actors carrying out R&D, almost the only revenue with potential job retention. In principle, the system of the National Research, Development and Innovation (NRDI) Office can be appropriate for the provision of such resources, and in addition to the governmental supervision and substantial involvement in space research and space activities, it is also worth taking advantage of the existing tendering institutions. For obvious reasons, however, the tendering system may not generate the provision of costs for the ESA and other multi- and bilateral collaborations that has to remain the task of sectoral budget. The research-centric character of Hungarian space industry is historically determined, thus with a few exceptions, the relationship with production has to be encouraged. The combination of education, research and production is not coherent; the information flow, which is needed for cooperation, is lacking. The formation of cooperation across the entire life-cycle of product development has to take place along a consistent and common project approach and implementation in terms of industry and research. At the beginning of R&D process, the aim is to increase the rate of demand-responsive research by the involvement of industry actors in basic research that will ensure the run-up of implementation and market use. In the second half of the process, it is expedient to link the research sites to product development phases, thereby emerging competences and economic return can also reach the scientific activities besides the industry actors. The project-based linkage does not constitute long-term solution to the problems outlined above, however, for the actors, it means learning new and changing competences in each development cycle. Due to their limited resources, participants of the Hungarian space industry find it difficult to join in the international value-chain on their own. In many cases, although they possess the necessary technological skills, they cannot reach the relevant undertakings. A project-based support is required that is based on the joint participation of research sites / universities and companies, thus helping to spread the currently missing market and management knowledge among scientific actors, and the more active participation of engineers in scientific work and education.
Connection with other measures	1.1.1 Tender-based support for R&D groups and enterprises (support for networking of space companies and research sites) 1.2.1 Fostering incubation activities in space science and space engineering research and/or training sites

	1.1.4 Encouraging the shift towards a knowledge-based economy through knowledge and technology intense investments 1.2.3 Supporting pilot projects for market-oriented use of research data, promoting trade activity 3.2.1 Performance-oriented development and support for the operational background of educational and research institutional system 3.2.2 Improving educational and research institute infrastructure, their technical and operational conditions

Interventions	***Responsible entities / Beneficiaries***
Elaboration of RDI tenders providing the possibility to support RDI activities related to space economy, space industry and space research	MFAT / NRDI Office
Selection of professional assessors	MFAT
Securing resources over financial cycles	Ministry of Finance / MFAT / NRDI Office
Establishing an interface supporting tenders and R&D collaborations	MFAT / ITM
Central strategic and operative support covering the full TRL scale: fostering regular forums supporting the projects, professional consultancy, facilitating finding partners, establishing representation of interests; mentoring	MFAT
Developing an application interface	MFAT
Developing R&D short-term strategy for domestic actors	MFAT / ITM
Call for proposals for major domestic projects	MFAT / ITM

Project selection criteria	● Researcher competence ● Space heritage ● Potential for participation in ESA or other international projects ● Available infrastructure

Indicators
Output indicators
Increase in the number of applicants
Intensification of spin-off processes
Market-based sale of developments
Increase in the number of R&D professionals and employees
Increase in the number of supported applications
Increase in the number of accredited actors
Increase in the number of project level international collaborations
Result indicators
The ratio of R&D outgoings to GDP is increasing
The actors' market share / sales revenue is increasing
The average level of TRL ratings is increasing

Measure	**1.1.2 Tender-based encouragement of business collaborations**
Overall objectives	● Strengthening knowledge transfer ● Encouraging innovation ● Generating multiplicative effect in the effectiveness of R&D sector ● Achieving stronger position in case of participation in international tenders
Justification for its necessity	Desired consortium collaborations can be fostered by tender structures. The product or service produced in this form is much more complex, thus it has a higher added value. It is also an important aspect that corporate collaborations may induce new structures and formation of new enterprises. It is also important to create institutional channels for domestic companies in space sector, and establish government partnership forums. Developing a funding, legal and professional supportive framework is essential for the domestic space sector with a complex structure and many actors. In addition, standards and accreditation processes are often prerequisites for participating in international projects and obtaining grants. Participation in bilateral or multilateral developments, as well as the use of the common European infrastructure, requires knowledge of the legal and organisational conditions of the partners, and the use of experiences gained this way in institutionalised territorial cooperation. Thereby, possible duplications arising this way, may be avoided, and a consistent planning process and increase in the intensification of consultations may promote successful development of the sector.
Connection with other measures	1.1.1 Tender-based support for R&D groups and enterprises (support for networking of space companies and research sites) 1.1.2 Tender-based encouragement of business collaborations 1.2.3 Supporting pilot projects for market-oriented use of research data, promoting trade activity 1.4.1 Promoting formation of a future-oriented economic structure; 1.4.2 Improving economic competitiveness based on new technologies; 1.4.3 Strengthening Hungary's economic potential through increasing added value of space sector 2.1.1 Building the structure of domestic regulatory, organisational framework and financial incentive system for space activities, creating the legal harmonisation in the EU 3.2.1 Performance-oriented development and support for the operational background of educational and research institutional system 3.2.2 Improving educational and research institute infrastructure, their technical and operational conditions

Interventions	***Responsible entities / Beneficiaries***
Incubation	MFAT
Upskilling programmes	MFAT
Fostering clustering processes	MFAT

Project selection criteria	● Professional competences ● References ● Stable economic background ● Human resources

Indicators
Output indicators
Number of subsidized companies is increasing
Number of project level collaborations is increasing
Result indicators
Participation in supported international tenders is increasing
Connections of Hungarian actors are expanding
Number of those who join in the international value chain is increasing

1.2 Specific goal: Building targeted competences in the segments with high market potential

Measure	**1.2.1 Fostering incubation activities in space science and space engineering research and/or training sites**
Overall objectives	● Strengthening spin-off effects ● Increase of market revenues ● Partial independence from public funding ● Applying economic skills during R&D
Justification for its necessity	In addition to the experts' professional knowledge in the narrow sense, they have to know the current market processes, domestic and international tendering opportunities. Enabling Hungarian professionals to sell their knowledge on market basis, as well, contributes to the expansion of domestic space economy. In parallel with this step, **an incubation environment for start-up enterprises should be ensured** that helps small businesses getting through initial difficulties, in order to become fully autonomous actors in domestic and international economic processes later on.
Connection with other measures	1.1.1 Tender-based support for R&D groups and enterprises (support for networking of space companies and research sites) 1.1.2 Tender-based encouragement of business collaborations 1.1.3 Promoting and supporting the establishment of spin-off firms 1.2.1 Fostering incubation activities in space science and space engineering research and/or training sites 1.2.3 Supporting pilot projects for market-oriented use of research data, promoting trade activity 1.4.1 Promoting formation of a future-oriented economic structure 1.4.2 Improving economic competitiveness based on new technologies; 1.4.3 Strengthening Hungary's economic potential through increasing added value of space sector 2.1.1 Building the structure of domestic regulatory, organisational framework and financial incentive system for space activities, creating the legal harmonisation in the EU 2.3.2 Fostering international trainings, upskilling 3.2.1 Performance-oriented development and support for the operational background of educational and research institutional system 3.2.2 Improving educational and research institute infrastructure, their technical and operational conditions

Interventions	***Responsible entities / Beneficiaries***
Elaboration of upskilling programmes	MFAT / ITM
Developing grant application and support system	MFAT / ITM

Project selection criteria	● Professional competence ● Actual development potential ● Ability to serve market capabilities

Indicators
Output indicators
Number of participants in incubation is increasing
Follow-up experiences are positive: rate of market entry is increasing
Result indicators
Increase in the number of enterprises in space sector
More successful ESA applicants
Number of companies with high added value is increasing
Number of workplaces is increasing

Measure	**1.2.2 Supporting development of industrial and production capacity**
Overall objectives	● Creating new jobs ● Higher contribution to domestic GDP ● Production of export articles ● Establishing new supplier chains ● Strengthening the inflow of working capital
Justification for its necessity	Building domestic production capacities helps supplier chains to be developed and steadily maintained. By use of experiences of several industrial areas, employing incentives, and formation of strategic partnerships, it is worth to secure the environment for the dominant actors in global market, whereby establishing Hungarian production capacities can be decided. Obviously, along the domestic financial and economic realities, a more complex, domestically owned industrial capabilities should be facilitated, as well.
Connection with other measures	1.1.1 Tender-based support for R&D groups and enterprises (support for networking of space companies and research sites) 1.1.3 Promoting and supporting the establishment of spin-off firms 1.1.4 Encouraging the shift towards a knowledge-based economy through knowledge and technology intense investments 1.2.1 Fostering incubation activities in space science and space engineering research and/or training sites 1.4.1. Promoting formation of a future-oriented economic structure 1.4.2 Improving economic competitiveness based on new technologies 1.4.3 Strengthening Hungary's economic potential through increasing added value of space sector 2.1.1 Building the structure of domestic regulatory, organisational framework and financial incentive system for space activities, creating the legal harmonisation in the EU 2.2.1 Strengthening regional role (Establishment of V4 Space Cooperation) 2.2.2 Security policy role, strengthening capabilities and national integrity (EU, UN, NATO space defence) 3.2.1 Performance-oriented development and support for the operational background of educational and research institutional system 3.2.2 Improving educational and research institute infrastructure, their technical and operational conditions

Interventions	***Responsible entities / Beneficiaries***
Entering into strategic partnerships with international integrator companies	MFAT

Active support for domestic developments (tax incentive, investment aid)	MFAT / Ministry of Finance
Facilitating compensation for supply of domestic developments	MFAT
Developing financial instruments for business development	MFAT / Ministry of Finance

Project selection criteria	● Ability to increase capacity of Hungarian suppliers ● Added value ● Creating jobs with the ability to generate real, high added knowledge ● Substantial contribution to GDP

Indicators
Output indicators
Number of strategic partnership agreements
Number of subsidized domestic developments
Number of calls for proposals
Number of established financial and capital market products (capital base, credit arrangement, etc.)
Result indicators
Increase in the volume of export
Value of related investments
Increase in the production value
Increase in the number of jobs

Measure	**1.2.3 Supporting pilot projects for market-oriented use of research data, promoting trade activity**
Overall objectives	● Manufacturing marketable products ● Converting knowledge of the academic sphere to marketable products, services ● Strengthening marketing and communication abilities ● Strengthening business mentality in public sector
Justification for its necessity	Several relevant developments with a view to market are taking place in universities and academic research institutes. However, access to the market for these potential saleable products has not been resolved yet. It is necessary to create channels that can form bridges between publicly owned research sites and private sector. Basic research carried out by research institutes achieves level 4 on the Technology Readiness Level (TRL). The development of pilot projects could serve to broaden the internal user market, aimed at demonstrating and popularising the practical, economic utilisation of research data, primarily earth observation data. Supporting this has the positive effect of requiring a market-exploring, market-centric attitude on the part of researchers, as well. Training of users, presenting best examples, conferences, publications and free upskilling may help the widespread use of data, the development of a precision economy both in the field of agriculture (estimate of the crop, irrigation systems, optimal land use, water management, etc.) and in the field of climate change (identification of heat islands and frost pockets, forecasting of extreme weather

	events, etc.). This also requires the establishment of a network of national counselling experts.
Connection with other measures	1.1.1 Tender-based support for R&D groups and enterprises (support for networking of space companies and research sites) 1.1.3 Promoting and supporting the establishment of spin-off firms 1.1.4 Encouraging the shift towards a knowledge-based economy through knowledge and technology intense investments 1.2.1 Fostering incubation activities in space science and space engineering research and/or training sites; 1.2.2 Supporting development of industrial and production capacity 1.2.3 Supporting pilot projects for market-oriented use of research data, promoting trade activity 1.4.2 Improving economic competitiveness based on new technologies; 3.1.3 Building interdisciplinary knowledge platform in space sector, dissemination of innovations, integrated interconnections of university courses;

Interventions	***Responsible entities / Beneficiaries***
Call for proposals to strengthen the process	MFAT / ITM
Involvement of organisations that strengthens knowledge transfer by their activities	MFAT / ITM

Project selection criteria	● Reality of market needs ● Market-oriented management ● Actual skills

Indicators
Output indicators
Achieving higher TRL during R&D
Serving market needs
Export activities
Result indicators
Increasing export activities
Increase in the revenue of enterprises
Increasing social visibility of the Hungarian space industry
Creation of jobs that can produce high added value

1.3 Specific goal: Integration development of the space sector

Measure	**1.3.1 Horizontal and vertical data harmonisation, increasing data processing capacities**
Overall objectives	● Assisting to governmental actors in the flow of information ● Strengthening practical application of space technology in the public sector, as well ● Launch of practical application of FIR-FOK data centre ● The possibilities provided by space technology should be taken into account in the necessary IT developments
Justification for its necessity	Currently, there is a lack of institutional background for the data flow provided by space technology that could be used and purchased by the state and governmental institutions. Central systematisation and transmission of data, and possible harmonisation of procurement tasks would help actors with different functions to have quick access to data that are relevant to them. It is necessary to coordinate both institutional and infrastructural development needs of government actors. A desirable goal is to create professional forums in this area, in order to let various policy leaders know about the tasks taking place at other levels of the government, thereby avoiding undesirable parallelism and providing opportunity for engagement in other projects. Exploiting the capabilities of the established FIR-FOK data centre could provide a good basis for acquiring the necessary skills. In the new data-oriented world, satellite information is becoming an increasingly important scientific and economic factor for both public and market actors in the future. These are often available for free. The aim is to develop methods, AI-based algorithms that can provide a more complex solution than free services. Ground reference data, reference measurements may constitute a market advantage, as the measurement networks has to be operated, which is not profitable for small companies. On the one hand, there is a need for linking biophysical parameters with satellite images, on the other hand it would be expedient to integrate the hardware, measurement networks and research of the activities existing in several places in the country into a unified system. This potential can be created within the FIR-FOK system. An important task is to provide legal and financial support for data access and data exchange between sectors and state-economic actors. One of the basic requirements for the creation of open data platforms is the appropriate level of normative support for data owners, thus costs of data production should not be charged to users who are often financed from also this budget. Open data platforms provide multiple returns at the national economic level, as in our days, data-based research, economic activities and decision-making are increasingly competitive advantage.
Connection with other measures	1.3.3 Incorporating data from space activities into a standardised system, establishing data centres; 1.3.4 Resolving barriers to data access, supporting open data platforms 1.4.1 Promoting formation of a future-oriented economic structure; 1.4.2 Improving economic competitiveness based on new technologies; 2.1.3 Awareness raising, building knowledge dissemination and support; 2.2.2 Security policy role, strengthening capabilities and national integrity (EU, UN, NATO space defence)

	3.1.2 Developing user capabilities related to space technology; 3.1.3 Building interdisciplinary knowledge platform in space sector, dissemination of innovations, integrated interconnections of university courses;

Interventions	***Responsible entities / Beneficiaries***
Establishing Governmental Conciliation Body	MFAT / Prime Minister's Office
Organising professional upskilling	MFAT / Prime Minister's Office

Project selection criteria	● Relevant technological skills and system of state and governmental tasks ● Need for training and human resources development

Indicators
Output indicators
Higher data usage
Related IT developments
Increase in data communications
Result indicators
More effective performance of state / governmental roles
Appearance of more accurate information
Quickening decision-making
Appearance of higher-level capabilities

Measure	**1.3.2 Establishing internationally accredited test centre, standardising testing capacities**
Overall objectives	● Multiplication of valuable research competences ● Utilisation of market potential ● Enforcing competence-based competitive advantages ● Establishing market niche and regional leading role in the field ● Competitive service, sustainable operation ● Competitive advantage
Justification for its necessity	Space objects are already exposed to extreme radiation even in orbits near Earth, as they are not protected by magnetic shield of our planet. Furthermore, they have to be functional at extreme fluctuation of temperature that is unimaginable on Earth. It is extremely important that extraordinarily complicated objects should endure the forces during blast-off. In any case, industrial and scientific objects in space are required to be tested on Earth to prove their operationality in principle. At present, such laboratories and test centres are located in Western Europe, and it is extremely expensive to use their services. However, without testing, even the smallest component cannot be installed in the space object. Without qualification of the components, Hungarian industrial actors are often forced to purchase export products certified in other test centres. However, their price is several times higher than the price at which domestic industry could produce a given component. A test centre operating with a qualification system that suits both Western and Eastern standards, provides a cost-effective solution not only for the domestic

	industry, but the appearance of a potential European client base can be prognosticated, as well. Return on the project is expected, as the radiation test environment is also suitable for testing objects operating in a nuclear environment, therefore also provides a valuable opportunity for nuclear energy industrial actors.
Connection with other measures	1.2.3 Supporting pilot projects for market-oriented use of research data, promoting trade activity

Measures	***Responsible entities / Beneficiaries***
Carrying out an extensive sectoral needs assessment, integrating results-based actions synchronised with research institutes	ITM, relevant sectors involved in space service, MFAT
Evaluation of the benefits obtained by creating the data network (complex indicators, information relations), preparation of synthesis	ITM, MFAT
Elaborating research, market and utilisation strategy based on data integration	ITM, MFAT
Drawing up a decision-preparatory document on the possibilities for international extension of domestic data network, international project proposal	ITM, MFAT

Project selection criteria	● An institution with adequate competence ● Location within the country ● Industrial background

Indicators
Output indicators
Number of databases connected to the network is increasing
Number of relevant research sites is increasing
Number of studies, strategies is increasing
Number of international project proposals based on market-oriented data use is increasing
Result indicators
Domestic market share of space services is increasing
Revenue of research sites is increasing

Measure	**1.3.3 Incorporating data from space activities into a standardised system, establishing data centres**
Overall objectives	● Multiplication of valuable research competences ● Utilisation of market potential ● Enforcing competence-based competitive advantages
Justification for its necessity	The primary and additional research competences of Hungary's space research institutions cover almost the entire spectrum of space activities. Its comparative advantage is realised in the field of space communications and navigation, supplementing with the Earth Observation areas, the necessary capacities for this are available in six research sites in our country. Based on the above, exploitation of market potentials in data processing can be ensured by harmonisation of research, IT capacities and measurement networks, according to the researchers concerned. The degree of integration of scientific

	institutions in the international value chain is generally ensured, however, there are further possibilities for connecting domestic terrestrial measurement systems operated by universities (e.g. meteorological network) into a reference data network. Hungary has a unique space weather measurement network in the world.[47]
Connection with other measures	1.2.3 Supporting pilot projects for market-oriented use of research data, promoting trade activity 1.3.1 Horizontal and vertical data harmonisation, increasing data processing capacities 1.3.4 Resolving barriers to data access, supporting open data platforms 2.2.1 Strengthening regional role (Establishment of V4 Space Cooperation) 3.1.2 Developing user capabilities related to space technology

Interventions	***Responsible entities / Beneficiaries***
Carrying out an extensive sectoral needs assessment, integrating results-based actions synchronised with research institutes	ITM, relevant sectors involved in space service, MFAT / an institution responsible for governmental coordination
Evaluation of the benefits obtained by creating the data network (complex indicators, information relations), preparation of synthesis	ITM, MFAT
Elaborating research, market and utilisation strategy based on data integration	ITM, MFAT
Drawing up a decision-preparatory document on the possibilities for international extension of domestic data network, international project proposal	ITM, MFAT

Project selection criteria	● State's role

Indicators
Output indicators
Number of databases connected to the network is increasing
Number of relevant research sites is increasing
Number of studies, strategies is increasing
Number of international project proposals based on market-oriented data use is increasing
Result indicators
Domestic market share of space services is increasing
Revenue of research sites is increasing

[47] Space weather is one of the most relevant areas in the space sector. Detection and forecast of space weather events is one of the new, market services.

2.1 Specific goal: Supporting Hungarian space activities through central coordination, institutional background and complex national communication

Measure	**2.1.1 Building the structure of domestic regulatory, organisational framework and financial incentive system for space activities, creating the legal harmonisation in the EU**
Overall objectives	● Developing a common space law that creates the regulatory, organisational, structural and financial framework for the Hungarian space activities ● International legal harmonisation ● Developing a framework to support the development of actors ● Organisational development of space companies ● Expansion of Hungarian space competences and capacity
Justification for its necessity	For the domestic space sector with complex structure and many actors, it is essential to establish a regulatory, financing and structural framework laid down by law in order to carry out more efficient coordination of Hungarian space activities and to further accomplish international relations that is provided by the legislator in the form of space law in accordance with the international practice. In the absence of an individual space agency, addressing market entry barriers faced by certain actors, is not adequately solved. In many cases, companies preparing to enter the space industry and those that are already present, lack the organisational development expertise, which could bridge the problems of management and growth constraints, and the expectations of the owner's circle. In addition, standards and accreditation processes are often prerequisites for participation in international projects and obtaining grants. Participation in bilateral and multilateral developments, as well as the use of the common European infrastructure, require the knowledge of legal and organisational circumstances of the partners, furthermore the use of acquired experiences in the institutionalised territorial cooperation. In the Hungarian context, results of the space activities appear independently in the different sectors, fragmented, with individual contracts. A regulatory system and planning process defined in a uniform law would contribute to avoiding possible parallelism and duplications resulting from the current isolated operation.
Connection with other measures	1.1.2 Tender-based encouragement of business collaborations 2.1.2 Elaborating and operating an accreditation and monitoring system 2.2.3 Strengthening the role of Hungarian diplomacy in ESA/EUSPA 2.3.3 Ensuring personal and material conditions for international relations

Interventions	***Responsible entities / Beneficiaries***
Developing a common space law that creates the regulatory, organisational, structural and financial frameworks of the Hungarian space activities	MFAT, Ministry of Justice
Exploring, analysing and evaluating the legal environment of space activities inside and outside the EU	Ministry of Justice, MFAT
Concluding the legal harmonisation process	Ministry of Justice, MFAT

Establishing a legal harmonisation database and query system for monitoring the actual performances	Ministry of Justice, MFAT
Participation in preparation of EU strategic documents	Ministry of Justice, MFAT
Intersectoral regulation of space-related processes, securing scope of activities and sub-area competences	MFAT, Ministry of Justice

Project selection criteria	● Priority state responsibility

Indicators
Output indicators
Realisation of relevant laws is increasing
Number of EU space / strategy documents prepared with Hungarian involvement is increasing
Number of sectoral statutes affected by space activities is increasing
Result indicators
Participation in supported international tenders is increasing
Connections of Hungarian actors are expanding
Number of those who are joining the international value chain is increasing

Measure	**2.1.2 Elaborating and operating an accreditation and monitoring system**
Overall objectives	● Cataloguing competences associated with space activities in Hungary ● Cooperation within space sector ● Integration into the international value chain ● Established decision-making system ● Strengthening knowledge transfer, knowledge triangle (education, research and innovation) ● Increasing spin-off effect
Justification for its necessity	Facilitating the information flow and coordination among domestic space actors contributes to the development of extensive cooperation. One of the tasks of a central coordinating organisation to be set up at a later stage would include the creation of a database that collects and makes available both the industrial, research and educational skills, references, and the available capacities (assets and testing), continuously updating the information. The first step is to create a catalogue of competences, which can serve as an accreditation system, as well as a database to assist in the evaluation of the project-based grants and thematic proposals. Currently, there is no such a domestic qualification system for the research institutes and space actors both in the domestic and international context that would provide a coherent basis for finding partners and selection of beneficiaries, and their involvement in some kind of structure (i.e. as supplier). Space heritage, standards and accredited processes are necessary for international market access, the acquisition of which is a burden on companies that cannot be undertaken by many, even a multi-annual, resource- and cost-intensive procedure. Support for accreditation is one of the main tools of joining in the international value chain, as adaptation of standards needed for international market development can be achieved through it. These standards clearly ensure the

	quality and reliability conditions for space industry, and the lack of it is a plain entry barrier for companies operating in the field. In addition to international standards (ISO, ECSS, GOST, OST), specific actors in the industry often apply accreditation systems developed and verified by themselves. On the one hand, these contributes to maintaining the required standard in the sector, on the other hand, they generate further costly and time-consuming conditions for enterprises that are not solvent. Standards cover the entire spectrum of activities in the manufacturing sector and they are often the primary barriers to entry into supply chains. These standards are either revived specifically by the space sector, or process management and quality assurance methods are used that are well-established in other industries. Currently, the number of companies in Hungary that are able to meet the described qualification requirements is low.
Connection with other measures	1.1.1 Tender-based support for R&D groups and enterprises 1.4.1 Promoting formation of a future-oriented economic structure 1.4.2 Improving economic competitiveness based on new technologies 1.4.3 Strengthening Hungary's economic potential through increasing added value of space sector 2.1.1 Building the structure of domestic regulatory, organisational framework and financial incentive system for space activities, creating the legal harmonisation in the EU 2.3.1 Supporting the expansion of Hungary's role in international research programmes

Interventions	***Responsible entities / Beneficiaries***
A comprehensive mapping of actors in the space sector, with a preliminary questionnaire survey on the content of the proposed database	ITM, MFAT
Creation of a database (competences, tenders, international cooperation references, academic degrees, TRL, patents, SCOPUS publications, corporate commendatory reference texts, etc.)	MFAT
Creating a transparent surface on domestic competences available to space actors, international, economic and state areas	MFAT
Establishing a system supporting the acquisition of an international accreditation qualification, according to the model of the Austrian ASAP (Austrian Space Applications Programme)	ITM, MFAT, Ministry of Justice
Establishing a structure to reduce the administrative and other burdens accompanying accreditation	MFAT

Project selection criteria	● State responsibility

Indicators
Output indicators
Number of accredited companies and organisations is increasing
Number of subsidized companies is increasing
Number of companies introducing international standards is increasing

Result indicators
Number of obtained tenders with participation of Hungarian actor is increasing
Return on Hungary's payments to ESA is increasing
Innovation capacity is expanding
R&D rate within the GDP is increasing

Measure	**2.1.4 Launch of flagship projects (Hungarian research astronaut mission, individual satellite programme, expansion of capacity of ground receiving stations, Radiation Effects Testing Laboratory)**
Overall objectives	● Accelerating domestic developments ● Creating market for domestic actors ● Making the sector visible by clearly visible projects ● Increasing domestic space capacities ● Expanding Hungarian space capabilities ● Creating long-term institutional bases
Justification for its necessity	In addition to smaller intervention points, it is important to have large projects known to everyone. Flagship projects are suitable for making the Hungarian space research visible to both domestic and international audiences, including economic and political actors. Hungary's Space Strategy distinguishes four key flagship projects: **<u>Hungarian research astronaut mission</u>** Hungary's strategic interest is to preserve and develop its necessary competences for space activities, and to strive for strengthening its position in the intensifying international competition in space activities, building on its decades-long tradition, taking advantage of the current favourable conditions for the realisation of successful international collaborations. The MFAT is conducting international negotiations in order to reopen the opportunity for Hungary to send a Hungarian research astronaut into space for the first time since 1980, who could perform a long-term service at the International Space Station, and participate in the mission with individual Hungarian experiments and instruments developed in Hungary. This option is also unique in terms of its economic importance and scientific value, and it would make a significant contribution to the promotion of the Hungarian space industry, research institutes operating in the field of space research and, in a broader sense, the scientific fields. Space flights with a human being are not only valuable by themselves, but by participating in a research astronaut mission, Hungarian space companies and higher education institutions will have space heritage through the developed objects and/or knowledge that is a precondition for entering the global market. Thus, the objects and experiments sent up to the International Space Station (ISS) can provide a basis for space companies producing typically for export, high value-added products or services, and a basis for significant international research results. The international experience regarding implementation of the research astronaut mission would significantly raise Hungary's role in the international

	space competition, creating a significant competitive advantage for Hungary in the field at regional level, as well. **Individual satellite programme** In August 2020, 4iG PLC. (51%), Antenna Hungária CPLC. (44%) and New Space Industries CPLC. (5%) established a joint venture, called CarpathiaSat CPLC. The aim of CarpathiaSat CPLC. is to launch on a geostationary earth orbit in 2024, and to operate Hungary's first satellite that is suitable for commercial, governmental and scientific research tasks in the long term, along with additional supplementary satellites. The implementation of an individual satellite programme in the field can be considered as a strategic interest both in terms of long-term competitiveness and maintaining autonomy. Preparation, implementation and long-term operation of the project will create significant market opportunities for Hungarian universities, R&D and industrial actors, and contribute to strengthening Hungary's position in international space competition. **Expanding the capabilities and capacities of the ground receiving station, establishing an up-to-date antenna system** It is essential to maintain connection between the Earth and satellites, which are trunk-transmitter of space activities, as the data transmitted by the satellite should be received on the surface by appropriate objects. The presence of a receiving station is the precondition for a country to be able to communicate with space objects in a sovereign way. Expanding and developing the capacities is necessary for Hungary in order to gain sovereign communication abilities with the increasing number of objects installed in the outer space. For this purpose, it is necessary to build a remote-controlled tracking antenna system consisting of several antennas, which is suitable not just for domestic use, but also serve as a service to communicate with space objects of other, typically international actors, thus as a service provider it can also be operated on a market basis. The construction of a high-quality satellite dish and transmitting station system is an unavoidable step toward developing Hungary's space research and industrial competences, and increasing the sovereignty of our country. **Radiation Effects Testing Laboratory, developing ground testing environment** In line with Hungary's Space Strategy, it is necessary to establish not only the communication, perceptual infrastructure, but also the Radiation Effects Testing Laboratory as an essential infrastructure that plays an exclusive role in the preparation of objects designed for space (satellites and instruments on it) and human expeditions. The simulation of radiation effects on space objects and astronauts under ground conditions can be performed with particle accelerators. The planned investment in the Radiation Effects Testing Laboratory is a complex irradiation centre that, if fully built up, can be an institution validated by the ESA, thus its use is unavoidable during the ESA missions. At the same time, in line with

	the Hungarian research, health and industrial trends, the use of the planned centre goes beyond space research. The ability created by the Radiation Effects Testing Laboratory: material scientific, radiobiological, space medical and radiation protection preparation for space missions and space travels in state of the art. In the long term, it will be a unique interdisciplinary research and higher education centre that can be suitable for supporting several further R&D&I activities in addition to sciences related to space research. Additional other types of testing capacity development (vacuum, thermal testing, shaking and mechanical testing environment, etc.) are also substantial in order to increase industrial competitiveness and expand Hungary's leeway in the international market and business opportunities of testing. Following the acceptance and finalisation of Hungary's Space Strategy document, along the objectives set out therein, a detailed presentation and description of the flagship projects will be provided as part of the action plan to be developed.
Connection with other measures	1.1.2 Tender-based encouragement of business collaborations 1.1.4 Encouraging the shift towards a knowledge-based economy through knowledge and technology intense investments 1.2.1 Fostering incubation activities in space science and space engineering research and/or training sites 1.2.2 Supporting development of industrial and production capacity 1.2.4 State promotion and support for developing competences that enhances the efficiency of corporate management and strengthens the management approach 1.3.2 Establishing internationally accredited test centre, standardising testing capacities 1.4.1 Promoting formation of a future-oriented economic structure 1.4.3 Strengthening Hungary's economic potential through increasing added value of space sector 2.1.3 Awareness raising, building knowledge dissemination and support 2.2.1 Strengthening regional role (Establishment of V4 Space Cooperation) 2.2.2 Security policy role, strengthening capabilities and national integrity 2.2.3 Strengthening the role of Hungarian diplomacy in ESA/EUSPA 2.3.1 Supporting the expansion of Hungary's role in international research programmes 3.1.1 Introducing and maintaining secondary and higher education programmes, accredited space science and space engineering trainings with internships 3.1.2 Developing user capabilities related to space technology 3.1.3 Building interdisciplinary knowledge platform in space sector, dissemination of innovations, integrated interconnections of university courses 3.1.4 Creating a researcher career model 3.2.2 Improving educational and research institute infrastructure, their technical and operational conditions

Interventions	***Responsible entities / Beneficiaries***
Promoting and implementing creation of flagship projects by the state	MFAT / ITM / Ministry of Finance / Ministry of Defence

Creating developmental resources	MFAT / ITM, Ministry of Finance
Ensuring completion of tasks related to project management	MFAT / ITM / Ministry of Defence

Project selection criteria	● Economic effects ● Social effects ● Direct industrial development effects ● Industrial background ● Higher education and research institute background ● Geographical location ● Exploiting international advantages

Indicators
Output indicators
Large scale investments realised by state's involvement
Greater increase in the measure of capital investments realised by state coordination
Presence of Hungarian-owned large industrial enterprises in domestic space sector
Result indicators
Presence of regionally determinant companies
Realisation of historically significant projects
Strengthening Hungary's regional role
Increase in domestic demand for space industry products and services

2.2 Specific goal: Strengthening Hungary's diplomatic positions, increasing abilities to enforce its interests

Measure	**2.2.3 Strengthening the role of Hungarian diplomacy in ESA/EUSPA**
Overall objectives	● Strengthening Hungary's ability of representation of interests in the ESA and EUSPA ● Facilitating Hungarian industrial actors' participation in international projects ● Deepening Hungarian diplomatic connections ● Fostering expansion of Hungarian space competences and capacities
Justification for its necessity	<u>European Space Agency (ESA)</u> Hungary has gained access to the European Space Agency in 2015 that determines fundamentally the operation and development of the entire Hungarian space sector. As the last Member State to join the ESA, Hungary has a competitive disadvantage compared to countries accessed earlier, as they have had the opportunity longer to benefit from the use of the ESA knowledge base and infrastructure. In the balance of the country's payments, which can be refunded by participating in optional programmes, the return is currently low even at regional level. In order to increase it, efficient allocation of domestic resources knowing the accurate competences would be required. Hungary's lobbying force in the ESA depends largely on the number of delegates in relevant committees and working groups who could represent the domestic space policy interests. In addition to the delegated expert representatives in each working group, it would be highly important in terms of enforcing Hungary's interests, to ensure long-term permanent Hungarian representation through diplomatic staff and national experts assigned to the organisation. Ensuring local Hungarian presence is essential in order to take advantage of the ESA membership. Each ESA Commission delegate's line of duties plays a key role what projects Hungarian space industry actors can take part in. In addition to technical expertise, it is highly important that the delegates have a clear understanding of the operational and decision-making mechanism of the ESA. For an adequate representation of interests, it is also a prerequisite for the delegates to have an accurate knowledge of the competences and capacities of Hungarian space sector, including Hungarian space policy objectives, along which appropriate representation of interests can be ensured at all levels of the ESA communication. <u>EU Agency for the Space Programme (EUSPA)</u> From the first quarter of 2021, the European GNSS Agency, which has been overseeing the EU's Galileo satellite system for 15 years, continues its work under the name EUSPA with a significantly expanded portfolio. The Agency's main task is to implement the EU New Space Programme (2021-2027). In addition to the operative operation of the Galileo programme, the Agency is also responsible for carrying out the programmes related to the management of Copernicus Earth Observation satellite system and governmental satellite communication (GOVSATCOM). Given its importance, with its enlarged portfolio, EUSPA is the second most important actor besides the ESA in terms of its impact on the European space activities.

	Despite the fact that the topic is stressed and the importance of the organisation is growing, currently one Hungarian employee is working in the field of human resources at the Agency. The official delegation tasks are performed by the MFAT and commissioned external experts. For Hungary, at highly important theme fields such as Galileo, EGNOS and Copernicus programmes, and measurements aiming wide-ranging extension of services in Hungary, integration of the most important policies from the point of view of Hungarian space activities into the EU Space Programme, enforcing the interests can be adequately ensured only by strengthening the local Hungarian presence in the Agency.
Connection with other measures	2.1.1 Building the structure of domestic regulatory, organisational framework and financial incentive system for space activities, creating the legal harmonisation in the EU 2.3.3 Ensuring personal and material conditions for international relations

Interventions	***Responsible entities / Beneficiaries***
Ensuring local Hungarian presence in the ESA and EUSPA through diplomatic staff and seconded national experts	MFAT, Ministry of Justice
Expanding the network of commissioned contracted experts, developing competences	MFAT
Publishing calls for actual national experts on the websites	MFAT, Ministry of Justice
Signing Requesting Party Agreement	MFAT

Project selection criteria	● Priority state responsibility

Indicators
Output indicators
Changes in the number of assigned diplomatic staff and national experts in the ESA and EUSPA
Expanding the network of commissioned contracted experts
Increasing the participation rate in optional programmes compared to obligatory payments
Increase in the participation rate in EU Space tenders, increase in the number of successful proposals
Increase the number of visits to a website, which contains calls for proposals
Result indicators
Increase in the rate of successful Horizon Europe proposals
Increase in the average domestic TRL
Coverage of domestic TRL
Geo-return rate (return coefficient) in the programmes

2.3 Specific goal: Fostering our role in international programmes

Measure	**2.3.3 Ensuring personal and material conditions for international relations**
Overall objectives	● Increasing the international visibility of Hungarian space competences, while ensuring a coordinated, uniform international appearance ● International knowledge transfer ● Integration of Hungarian companies into the international value chain
Justification for its necessity	Enhancing international visibility of competences in the Hungarian space sector is an important factor regarding laying the foundation for long-term success of the sector. The unified, institutionally coordinated and supported Hungarian appearance in the internationally relevant forums would facilitate the possibility of access to international market of the Hungarian space actors. In the absence of adequate institutional support, the individual professionally competent companies that cannot appear in large-scale international events due to lack of resources, may get the opportunity to expand their international relations, and for international market development.
Connection with other measures	2.1.1 Building the structure of domestic regulatory, organisational framework and financial incentive system for space activities, creating the legal harmonisation in the EU

Interventions	***Responsible entities / Beneficiaries***
Supporting Hungarian participation in international forums (full cost cover, repayable credit, contribution: paying participation fee, promotion costs, etc.)	Industrial actors, research sites, MFAT
Organising internationally considerable events / organising them in Hungary	Industrial actors, research sites, MFAT
Elaborating application criteria	MFAT
Project selection criteria	● Existing accreditation rating of the parties / or strong references of one of the parties ● Marketability ● Cooperation experience ● Involving students and doctoral candidates ● Start-up enterprise

Indicators
Output indicators
Number of international projects with Hungarian participation is increasing
Number of Hungarian co-exhibitors and their satisfaction is increasing
Number of events in Hungary / year
Appearance of Hungarian research and industrial actors in international conferences, fairs, forums is increasing
Number of Hungarian presentations in foreign events is increasing
Result indicators
Awareness of Hungarian space actors is increasing

Economic importance of the Hungarian space activities is increasing (GDP-rate)

Measure	**2.3.4 Reorganisation of ESA BIC-TTO centre, and preparing for opening an ESERO office in Hungary**
Overall objectives	● Domestic expansion of space manufacturing ● Providing operational conditions for domestic support organisations ● Successful start-up incubation ● Increasing number of space companies entering the market ● Knowledge-intensive economy ● Expansion of innovative technologies ● Optimization of ESA BIC-TTO operation ● Preparation for opening ESERO office in Hungary
Justification for its necessity	In order to increase the number of enterprises entering the space sector, it is important to raise awareness of the field in the start-up world and related industries, and it is needed to provide the essential support, incubation background for the start. It is advisable to provide space research incubators for start-up companies in the field of space science and space engineering trainings, and related to research centres. Launch and operation of the space industrial start-up companies is supported by the ESA Business Incubation Centre (BIC), the Technology Transfer Office (TTO) and the Ambassador Platform. In the future, these three organisations will operate together under the name Space Terminal. It aims to cooperate and encourage businesses to turn space-related business ideas into start-ups. In Hungary, ESA BIC was launched in 2018, and currently 4 start-ups are participating in it. They participate in the programme for a year and a half on average. The contract with ESA is renewable every 5 years, during which period 25 start-ups should be incubated. For new ones, it is possible to enter twice a year. A Technology Transfer Office has been operating in Hungary since 2016, which contract has to be renewed every 3 years. The agreement has expired and has not been extended due to lack of resources, thus currently, its operation is suspended. In case of ESA BIC, it is an issue that grants are given not only to start-up enterprises, but to solvent enterprises that currently plan to enter the space services market. Accelerating the product development process and trade schedule of existing SMEs are the tasks that will be carried out in the future by the Spark Funding programme emerging under ESA.
Connection with other measures	1.1.1 Tender-based support for R&D groups and enterprises 1.2.1 Fostering incubation activities in space science and space engineering research and/or training 1.2.3 Supporting pilot projects for market-oriented use of research data, promoting trade activity

Interventions	***Responsible entities / Beneficiaries***
Re-launch of ESA BIC in Hungary as part of a larger incubator house	MFAT, ESA BIC
Creating the conditions for one-stop financing	MFAT, ESA BIC
Creating capital supplements and credit conditions	MFAT, Space Fund
Building up the framework for application and support system	MFAT
Facilitating finding partners (investors, venture capital investors, etc.)	MFAT

Business assistance, consultancy	MFAT

Project selection criteria	● Business plan in the medium term ● Filling the market niche ● Applying progressive technology

Indicators
Output indicators
Number of space/service start-ups operating in incubation is increasing
Number of start-up centres is increasing
Amount of domestic subsidy / own funds supporting incubation is increasing
Amount of relevant venture capital is increasing
Number of economically independent start-ups is increasing
Result indicators
Proportion of R&D&I within GDP is increasing
Share of space sector within GDP is increasing
Number/rate of employees in the sector is increasing

3.1 Specific goal: Long-term foundation and acceleration of human resources developments

Measure	**3.1.1 Introducing and maintaining secondary and higher education programmes, accredited space science and space engineering trainings with internships**
Overall objectives	● Engaging space science and space engineering training ● Training of new generation of professionals who have innovative and interdisciplinary knowledge ● Extensive collaboration between education and industry ● A coherent, validated training system with related supportive structure ● Inspiring knowledge transfer to the different age groups
Justification for its necessity	In many countries, including Hungary, it is important to ensure the new generation of professionals through natural sciences, mathematics and information technology (STEAM) trainings for students in order to continue meeting the growing labour market demands in this sector with outstanding development perspective. Education is currently divided among different ministries (Ministry of Human Capacities, ITM and MFAT). To support the space sector, knowledge transfer across age groups can be achieved through coordinated cooperation of state actors, civil organisations, education institutions and industrial enterprises along a specific vision of the future. On the one hand theoretical foundations of primary and secondary education need to be strengthened, on the other hand they need to be supplemented with practical elements. Practice-oriented training is also needed in higher education in cooperation with industrial partners. Best practices are available in Hungary, embracing, supporting and integrating them into educational programmes would stimulate development of the sector. Availability of education programmes offered by the European Space Agency needs to be improved in order to achieve higher utilisation than at present. Accredited trainings aiming the access to international compatibility facilitate the validation of degrees obtained, the smooth application of exchange programmes, and ultimately, they motivate the actors in the system. An important aspect is the development of interdisciplinary nature of the trainings, as it would have an added value increasing effect in addition to space research capabilities, if it is supplemented with medical, technological and agricultural engineering skills.
Connection with other measures	1.1.1 Tender-based support for R&D groups and enterprises 1.1.3 Promoting and supporting the establishment of spin-off firms 1.2.1 Fostering incubation activities in space science and space engineering research and/or training sites 2.1.2 Elaborating and operating an accreditation and monitoring system 2.1.3 Awareness raising, building knowledge dissemination and support 2.3.2 Fostering international trainings, upskilling 3.1.2 Developing user capabilities related to space technology 3.1.3 Building interdisciplinary knowledge platform in space sector, dissemination of innovations, integrated interconnections of university courses 3.1.4 Creating a researcher career model 3.2.1 Performance-oriented development and support for the operational background of educational and research institutional system

	3.2.2 Improving educational and research institute infrastructure, their technical and operational conditions
Interventions	***Responsible entities / Beneficiaries***
Developing a coherent, interdependent, overarching on primary, secondary and higher education programme focusing on space activities	ITM, Ministry of Human Capacities, MFAT, HCCI
Connecting experiences on accredited space scientific, space engineering courses to education programme	MFAT
Creating conditions for dual trainings, introducing internship programmes	Universities, Industrial actors
Developing interdisciplinary space science training through collaboration among universities	Universities

Project selection criteria	● Complexity of education programme ● As broad as possible national coverage ● Related space industrial partnership ● Existing international educational and training connections

Indicators
Output indicators
Number of those who complete courses is increasing
Relevant PISA results of secondary education institutions are improving
Number of lecturers is increasing
Number of university students is increasing (STEAM)
Number of employees in work-places related to domestic space sector is increasing (with follow-up)
Number of students involved in national projects is increasing
Number of participants in doctoral course is increasing
Number of students' scholarly circle projects and prizes is increasing
Result indicators
Number of career changers is decreasing
Lack of professionals is decreasing
Number of students participating in international trainings is increasing
Number of award-winner/successful projects is increasing

Measure	**3.1.2 Developing user capabilities related to space technology**
Overall objectives	● Facilitating exploitation of innovation potential through the opportunities provided by the space sector ● Expanding knowledge of domestic enterprises ● Familiarising Hungarian society with the importance of space sector ● Forming domestic public thinking through popularisation
Justification for its necessity	The development of individual skills concerns all subsystems of the education system. Knowledge of the society can be developed through appropriate training systems in order to exploit the potential in space sector. Students with an innovative approach can make use of their skills in the labour market later. Creating a knowledge-based society is unimaginable without space technology, thus handing over the skills is particularly important.

	Beyond education, the expansion of knowledge of enterprises is also a substantial element in order to become more competitive. It is important for a competitive enterprise to be aware of the possibilities in the new, space-based technologies, even if it is not expressly a space actor. Data revolution that is among others based on space technology, ensures several opportunities in the field of financial, trade, marketing, logistics and medical services. During education and training of governmental actors, it has to be taken into consideration that a number of new, space-based services can contribute to more effective fulfilment of the work processes.
Connection with other measures	1.3.4 Resolving barriers to data access, supporting open data platforms 1.4.1 Promoting formation of a future-oriented economic structure; 1.4.2 Improving economic competitiveness based on new technologies; 1.4.3 Strengthening Hungary's economic potential through increasing added value of space sector 2.1.3 Awareness raising, building knowledge dissemination and support 2.2.1 Strengthening regional role (Establishment of V4 Space Cooperation) 2.2.2 Security policy role, strengthening capabilities and national integrity (EU, UN, NATO space defence) 3.1.3 Building interdisciplinary knowledge platform in space sector, dissemination of innovations, integrated interconnections of university courses;

Interventions	***Responsible entities / Beneficiaries***
Incubation	MFAT
Upskilling programmes	MFAT
Communication campaigns	MFAT
Organising conferences	MFAT
Adapting international knowledge dissemination to domestic conditions	MFAT

Project selection criteria	● State and market knowledge demands ● Actual business development potential ● Availability of appropriate qualification level

Indicators
Output indicators
Involving market actors in the utilisation of space technologies
Increasing domestic demand for space-based services (Earth Observation, Communication, etc.)
Appearance of innovative products and services with high added value
Result indicators
Increase in the demand for data
Increase in the contribution to GDP produced by the services based on data processing
Increase in the capital inflow from innovative and creative industry

SECTORAL TASKS TO ACHIEVE THE SHORT-TERM OBJECTIVES OF THE STRATEGY

SPECIFIC GOAL	Measures / Interventions	SECTORS				
		MFAT	ITM	EMMI	IM	PM
1.1 Strengthening multiplicative effect of the Hungarian space sector	**1.1.1 Tender-based support for R&D groups and enterprises**					
	Elaboration of normative thematic application system	+				+
	Selection of professional reviewers	+	+			+
	Securing resources over financial cycles	+	+			+
	Creation of an interface to support tenders and R&D collaborations	+	+			
	Central strategic and operative support covering the full TRL scale, as well as creating regular forums supporting projects, professional consultancy, facilitating finding partners, representation of interests and mentoring	+	+			
	Creation of application interface	+				
	Developing R&D short-term strategy for domestic actors	+	+			
	Call for applications for domestic large projects					
	1.1.2 Tender-based encouragement of business collaborations					
	Incubation	+	+			
	Upskilling programmes	+	+			
	Facilitating clustering processes	+				
1.2 Building targeted competences in the segments with high market potential	**1.2.1 Fostering incubation activities in space science and space engineering research and/or training sites**					
	Elaboration of upskilling programmes	+	+			
	Formation of application and support system	+	+			
	1.2.2 Supporting development of industrial and production capacity					
	Entering into strategic partnerships with international integrator companies	+	+			
	Active subsidy for domestic developments (tax allowance, investment aid)	+	+			+
	Encouraging compensation for supply for domestic developments	+	+			
	Creation of financial tools for business development	+	+			
	1.2.3 Supporting pilot projects for market-oriented use of research data, promoting trade activity					

SPECIFIC GOAL	Measures / Interventions	SECTORS				
		MFAT	ITM	EMMI	IM	PM
	Call for proposals in a way that strengthens the process	+	+			
	Involving organisations fulfilling knowledge-transfer strengthening activities	+	+			
1.3 Integration development of the space sector	**1.3.1 Horizontal and vertical data harmonisation, increasing data processing capacities**					
	Establishing a governmental conciliation body	+	+			+
	Organising professional upskilling	+	+			
	1.3.2 Establishing internationally accredited test centre, standardising testing capacities					
	Developing an extensive sectoral needs assessment, integrating concerted actions with the research institutes based on the results	+	+			
	Evaluating the benefits of creating a data network, preparation of synthesis	+	+			
	Elaborating a research and market utilisation strategy based on data integration	+	+			
	Developing a decision preparatory document	+	+			
	1.3.3 Incorporating data from space activities into a standardised system, establishing data centres					
	Developing an extensive sectoral needs assessment, integrating concerted actions with the research institutes based on the results	+	+			
	Evaluating the benefits of creating a data network, preparation of synthesis	+	+			
	Elaborating a research and market utilisation strategy based on data integration	+	+			
	Developing a decision-preparatory document	+	+			
2.1 Supporting Hungarian space activities through central coordination, institutional background and complex national communicatio n	**2.1.1 Building the structure of domestic regulatory, organisational framework and financial incentive system for space activities, creating the legal harmonisation in the EU**					
	Establishing a uniform space law laying down the regulatory, organisational, structural and financial framework of Hungarian space activities	+			+	+
	Exploring, analysing and evaluating the legal environment related to space activities inside and outside the EU	+			+	
	Concluding legal harmonisation process	+			+	
	Establishing a legal harmonisation database and query system for the verification of effective completion	+			+	
	Participation in preparation of EU strategic documents	+			+	
	Cross-sectoral regulation of space-related processes, setting scope of activities and sub-area competences	+			+	

SPECIFIC GOAL	Measures / Interventions	SECTORS				
		MFAT	ITM	EMMI	IM	PM
	2.1.2 Elaborating and operating an accreditation and monitoring system					
	A comprehensive mapping of space actors with a preliminary questionnaire survey on the content of proposed database	+	+			
	Establishing a database (competences, applications, international cooperation references, academic degrees, TRL, patents, SCOPUS publications, company reference documents, etc.)	+	+			
	Establishing a transparent interface on domestic competences for space industry actors, as well as for international, economic and public sector	+				
	Establishing a system to support the acquisition of international accreditation according to the model of Austrian ASAP (Austrian Space Applications Programme)	+	+		+	
	Setting up a structure to reduce administration and other burdens related to accreditation	+			+	
2.2 Strengthening Hungary's diplomatic positions, increasing abilities to enforce its interests	**2.2.3 Strengthening the role of Hungarian diplomacy in ESA/EUSPA**					
	Ensuring local Hungarian presence in the ESA and EUSPA through diplomatic staff and seconded national experts	+				
	Expanding the contracted expert database, developing competences	+				
	Publishing the actual national calls for experts on the website	+				
	Signing Requesting Party Agreement	+				
2.3 Fostering our role in international programmes	**2.3.3 Ensuring personal and material conditions for international relations**					
	Support for uniform Hungarian participation in international forums (total cost cover, repayable credit, contribution: paying participation fee, promotion costs, etc.)	+				
	Organising internationally important events / planning them in Hungary	+				
	Elaborating application criteria	+			+	+
	2.3.4 Reorganisation of ESA BIC-TTO centre, and preparing for opening an ESERO office in Hungary					
	Re-launch of ESA BIC in Hungary as part of a larger incubator house	+				
	Creating the conditions for one-stop financing	+				+
	Creating capital supplements and credit conditions	+				+

SPECIFIC GOAL	Measures / Interventions	SECTORS				
		MFAT	ITM	EMMI	IM	PM
	Formation of application and support system	+			+	
	Facilitating finding partners (investors, venture capital investors, etc.)	+				
	Business assistance, consultancy	+				
3.1 Long-term foundation and acceleration of human resources developments	**3.1.1 Introducing and maintaining secondary and higher education programmes, accredited space science and space engineering trainings with internships**					
	Developing a programme that is coherent, interdependent, overarches on primary, secondary and higher education, and focuses on space activities	+	+	+		
	Feedback on experiences from accredited space scientific, space engineering courses into education programme	+	+		+	
	Creating conditions for dual trainings, introducing internship programmes	+	+			
	Developing interdisciplinary space science training through collaboration among universities	+	+			
	3.1.2 Developing user capabilities related to space technology					
	Incubation	+	+			
	Upskilling programmes	+	+			
	Communication campaigns	+	+			
	Organising conferences	+	+			
	Adaptation of international knowledge dissemination programmes to domestic conditions	+	+			

ACTION PLAN INTERVENTIONS UNDER THE SECTORAL OPERATIVE PROGRAMME FRAMEWORK

In parallel with the planning of Hungary's Space Strategy, the planning of the operative programmes related to the 2021-2027 European Union development cycle is taking place.

Without approved operative programmes, the interventions realised from these frameworks cannot be clearly defined yet. At the same time the main directions can be formulated from the policy directions determining the operative programmes, and based on the draft version of the Economic Development and Innovation Operational Programme Plus in Hungary (GINOP Plus).

Within the Research, Development and Innovation priorities of GINOP Plus, two specific objectives can be identified: "Enhancing research and innovation capacities and the uptake of advanced technologies" furthermore "Developing skills for smart specialisation, industrial transition and entrepreneurship". In the current phase of planning, within the former, strengthening research and technological infrastructures and their networks, as well as their development, a more effective utilisation of possibilities in international research infrastructures, fostering a more powerful integration in the European Research Area, strengthening knowledge transfer and support for competitive corporate RDI projects play an important role.

In case of the latter, mainly the skills development needed for successful domestic implementation of smart specialisation, supporting innovation processes from the human resources perspective, creation and development of platforms to promote the networking in the innovation ecosystem play a role.

1. Priority axis: Research, development and innovation

1.1. *Enhancing research and innovation capacities and the uptake of advanced technologies are in line with the RDI Strategy.*

Support for knowledge production: creation and development of research infrastructures and their networks, more effective utilisation of possibilities in international research infrastructures, fostering a more powerful integration in the European Research Area, and support for competitive research projects.

1.1.1 Tender-based support for R&D groups and enterprises

- **Elaboration of RDI tenders providing the possibility to support RDI activities related to space economy, space industry and space research**
- **Establishing an interface supporting tenders and R&D collaborations**
- **Central strategic and operative support covering the full TRL scale: fostering regular forums supporting the projects, professional consultancy, facilitating finding partners, establishing representation of interests; mentoring**
- **Developing R&D short-term strategy for domestic actors**

- **Elaboration of domestic large projects**

1.2.1 Fostering incubation activities in space science and space engineering research and/or training sites
- **Elaboration of upskilling programmes**
- **Formation of application and support system**

1.2.2 Supporting development of industrial and production capacity
- **Entering into strategic partnerships with international integrator companies**
- **Active support for domestic developments**
- **Encouraging compensation for supply for domestic developments**
- **Creation of financial instruments for business development**

2.3.4 Reorganisation of ESA BIC-TTO centre, and preparing for opening an ESERO office in Hungary
- Re-launch of ESA BIC in Hungary as part of a larger incubator house
- Creating the conditions for one-stop financing
- Creating capital supplements and credit conditions
- Facilitating finding partners (investors, venture capital investors, etc.)
- Business assistance, consultancy

2.2. *Developing skills for smart specialisation, industrial transition and entrepreneurship*

Support for the development of abilities and innovation processes that are needed for the successful domestic implementation of smart specialisation, from the human resources side.

1.2.4 State promotion and support for developing competences that enhances the efficiency of corporate management and strengthens the management approach

2.5 priority axis: Higher education, vocational training

2.5.1. *Improving the quality, effectiveness and labour market relevance of education and training systems to support the acquisition of key competences, including digital skills.*

Competitive, innovative higher education in order to strengthen the social and economic relevance of higher education.
Strengthening the quality, effectiveness and labour market relevance of vocational training.

3.1.1 Introducing and maintaining secondary and higher education programmes, accredited space science and space engineering trainings with internships
- **Developing a coherent, interdependent, overarching on primary, secondary and higher education programme focusing on space activities**
- **Connecting experiences on accredited space scientific, space engineering courses to education programme**
- **Creating conditions for dual trainings, introducing internship programmes**
- **Developing interdisciplinary space science training through collaboration among universities**

Digital Renewal Operative Programme (DIMOP)

1. priority axis: Digitization of public services

1.2. Data-driven public administration

Process automatization and automated decision-making
Applying Artificial Intelligence (AI) and robotisation in the field of public services

1.3.1 Horizontal and vertical data harmonisation, increasing data processing capacities

- **Organising professional upskilling**

1.3.3 Incorporating data from space activities into a standardised system, establishing data centres

- **Carrying out an extensive sectoral needs assessment, integrating results-based actions synchronised with research institutes**
- **Evaluation of the benefits obtained by creating the data network, preparation of synthesis**
- **Elaborating research, market utilisation strategy based on data integration**
- **Drawing up a decision-preparatory document on the possibilities for international extension of domestic data network, international project proposal**

RESOURCE DEMAND CONSIDERING ESTIMATED CAPACITIES[48]

The development of space industry even in times of crisis, has proved that the state and the governments within it have a significant, dual, stabilising and developing role in the uninterrupted operation of the sector, on the one hand by elaborating and implementing the strategies, on the other hand by ensuring incentive support for industrial orders related to space research, as well as by providing partial or full public financing for related education and research. Despite the crisis situations and the associated difficulties in securing budgetary resources and reallocations, most countries with a significant space industry treat the space sector as a national economy sector of key importance.

Regarding the domestic state of the space sector, differently from the international practice, a double tendency prevailed in the decades after the change of regime, until recently. In the academic circle, even in a narrow circle, support for the development process starting with the research phase has been maintained, and as a result, valuable results have been achieved (i.e. MASAT, ATL and SMOG satellites, instruments, etc.), while in the field of services building on space industry and associated sectors, it was essentially lacking. If differing support, creation of conditions and incentive for science, education, industrial and service areas remain, the synergies that could raise it to a higher level, cannot prevail considering the sector as a whole. Governmental subsidy in the field of research and education should be maintained and increased, including not only the operation of research sites, but also the various levels of primary, secondary and higher education. The Hungarian State secures the future of research by investments, and it is responsible for the new generation of professionals in the whole sector through education and its reform. In the industrial and service areas, a significantly more, other quality and scope of support than before is needed, with which it supports collaborations within the sector, reinforcing competitiveness,

- coordination, information and international representation of actors in the sector, and lobby activities,
- incubation of relevant start-up firms, establishment of spin-off companies,
- validation of space companies by establishing an efficient application and support system that enables the judgement of the marketability of their products, and by elaborating an accreditation system,
- establishment of an internationally accredited product testing facility for domestic companies that satisfies every demand,
- success in the international stage by strengthening the institutionalised state role expressing its commitment to the industry,
- the space industry sub-unit (subset, component) supplier companies with appropriate competences to become multi-component, higher level, sub-system suppliers,
- the broadening of space industry supplier circle by involving capacities prepared for and continuing high-tech manufacturing operating in other areas of the industry.

[48] This chapter is based on the publication prepared by the Economic Implications Research Team of the University of Public Service: ***Space industry manufacturing and industry development in Hungary***, *Space industry eco-system building* (2020).

Today, the need for resources, not to mention the research and higher education expenditures related to the space sector, can only be carefully estimated, and a greater rate of private assets, privileged loans, grants (repayable and non-repayable), tax incentives and the use of capital supplements can be also assumed. It is necessary to secure capital supplement for the small and medium-size enterprises (SMEs) in the space industry. Establishing separate state funds could be a solution for their financing.

The additional resources to be secured over five years can be outlined around HUF 30-35 billion that lead to a substantial shift in the direction of the described goals, besides strengthening the corporate commitment appropriate to the incentive, the educational, research, testing, quality assurance, logistics and governance environment, furthermore the international relations and the supportive change of attitude.

Whereas, without the establishment / substantial development of the ecosystem, state support and incentive for capacity building grounded on international private capital cannot be properly effective, sequentially, the construction of infrastructure creating the condition has a primary role. The ability to use repayable and non-repayable grants, the efficient use of resources without it is in question.

In the initial period of funding, "the costs of state/state-private infrastructure development supporting space industry, the condition-creating provider, as well as the resource demand serving the targeted rise of performances, gradually increasing incentive subsidies serving the capacity-building, innovation and competitiveness, will appear at the same time". In the same initial phase, it is necessary to secure financial resources for the sudden qualitative change in the education and training system. It guarantees the new generation of professionals, improvement of the background conditions of scientific activities, and primarily, supporting the above from the first steps, creation and operation of an institution for instance a space agency that provides complex coordination, communication and cooperation.

With the above-mentioned tools and steps implemented along the strategic principles (which form the basis for technical projection), there is a chance that competence centres will be established in the medium term. And the performance of the industry with estimated[49] turnover of around HUF 25-30 billion in 2020, while expanding its profile, may increase[50] significantly (at the same price as in 2020) to HUF 45-50 billion. Whereas, without incentive, condition-creating support, as shown above, it can be lagging behind in the medium term, in addition with the consequences that will have a negative impact on the general industrial growth.

As it is clear from the foregoing, it cannot be expected in this phase of development that all unit expenditures will show returns according to international trends. Consequently, the technical projection makes greater dynamics, 5-6 percent growth in the revenue likely than the condition-creating, more moderate period in the first phase, while competences of the domestic space industry are also adjusted to the needs that enable wider involvement of this sector in the implementation of the Hungarian satellite programme.

The realisation of short-term, basically condition-creating goals is inseparable from the medium- and long-term goals of the Hungarian space industry, they serve it and have to prevail in harmony with

[49] According to company surveys, more than 80% of the companies in this circle with a profile related to space industry and space economy have manufacturer and provider capacities in other directions, thus more accurate data than indicated are not available.

[50] Taking into consideration of the effects of inflation, this can be estimated about HUF 50-55 billion at current prices.

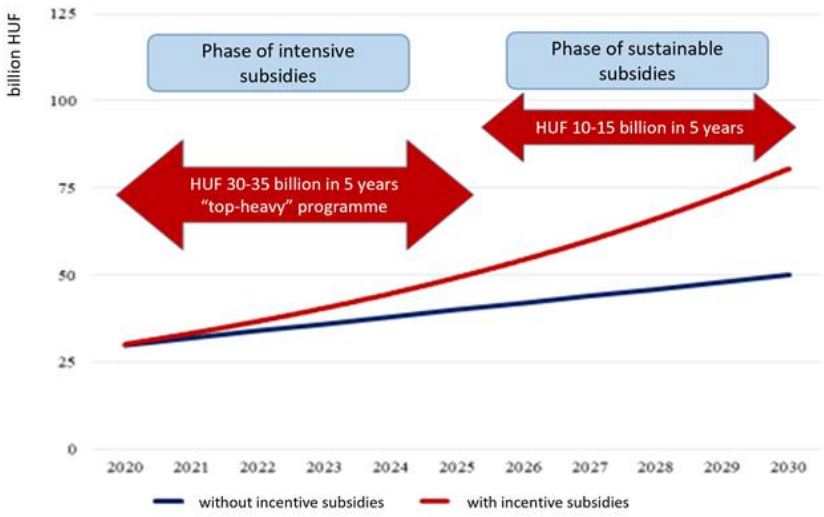
it. In order to achieve them, there is also a need for more complex actions, which after catching up, will help holding the position gained, and offer outstanding opportunity at the international level.

The amounts needed for a longer term are likely to be more modest, as instead of significant costs of building the supporting infrastructure, the costs of maintenance and maintaining modernness will occur, and as the sector strengthens, the level of incentive state subsidies may gradually decrease. For such projects, there is a need for the involvement of more significant public resources in the first phase, however, as several foreign examples show, due to the special role of the sector, where the state expresses its commitment to the development of the industry, market actors and private capital will appear in the short term. The rate of public and market investment in the sector is balanced out in a short period of time compared to other industries, and in most cases is even turning back.

Thus, **in this second phase**, in the long run, "a maintaining type", more modest source is needed than in the first phase, which can be estimated **at HUF 10-15 billion**, projected to the price level valid at the time of and within the limits of prognosis preparation and technical projection. As a result, assuming the demands of global development and also the continuity of development, the space industry capacity compared to today's level can double, and by the end of the decade, according to the technical projection, at unchanged price of 2020, it can reach HUF 80 billion revenue, almost triple.[51]

Chart 6 illustrates the expansion of space capacities with incentive subsidies and without them. The backlog is conspicuous, because the development of the domestic processing industry corresponds to the European medium category.[52] **Besides, in terms of public expenditures on the space sector in the countries with similar competences, the domestic spending is far below the average.**

Chart 6: Capacity of space industry, 2020–2030
Technical projection, professional prognosis



Source: University of Public Service, Economic Implications Research Team, 2020

[51] Taking into account the effects of inflation, this could approach or even exceed HUF 100 billion at current prices.

[52] See EUROSTAT, HCSO, OECD databases, country and thematic reports, furthermore Nagy, Benedek (2016) A magyar feldolgozóipar átalakulása 2008 és 2013 között: újraiparosodás vagy térbeli átrendeződés, Published: Lengyel, Imre – Nagy, Benedek (ed.) 2016: Térségek versenyképessége, intelligens szakosodása és újraiparosodása, JATEPress, Szeged, page 45–61

There are several solutions for the use and timing of the subsidy. It is possible to think in equal, same volumes annually, but it is practical to provide careful, incentive support gradually lessening financial background alongside the expected and identified goals and to their achievement. **Thus, by the end of the decade of 2020, it can be realistic to expect that the public/mixed resources invested in the first and second phases will finally jointly show returns.**

Further amounts should be counted to this, the amount that is refunded to the budget, appears in corporate taxation and disregarded in technical projection, along with the technical and technological synergies of development that are less easy to see, and will boost society and the economy as a whole, making it more competitive. Thus, return has to be examined in a broader sense, in social context, as well. [53]

The overlapping of the development phases of the space programme justifies the continuous provision of financial resources needed for the implementation in the long term in order to facilitate equal development.

However, within the scope of the Space Strategy, it is necessary to set further development strategic goals. On the basis of the incentive and financing role of the state, supporting implementation of development phases, in line with the expected level of revenue in the sector, based on technical projection, **the number of companies in the sector could double by 2025. This goal can be concluded from the sectoral characteristics in 2020.** Today, few companies in Hungary are involved in the space industry. **In 3-4-year perspective, the latest by 2025, it is a realistic goal to double the number of companies, and for some of the existing companies to achieve higher performance and strengthen their market position. On the basis of the estimated size of the sector, this would mean 60-70 companies within the emerging space industry ecosystem.**

From this it follows that doubling the number of employees in the space sector by 2025 is a realistic accompanying goal, including the increase in the number of researchers and experts.

The fulfilment of the scenario based on the incentive state role is also conditional on the increase in the number of subsidized companies that sets the important target to be achieved **by 2025, that is more than half of the companies in the sector could be included in the circle of subsidized companies**. The subsidized companies will allow a more intensive and increasing participation in the ESA, which will show returns in parallel with Hungary's higher payments to the ESA. If the state invests more in the national space industry through the ESA, the applicant companies will benefit from it, and research missions will be entitled to acquire space heritage (references).

In addition, the realisation of the scenario outlined and the growth of existing companies have a positive effect that more companies can switch size category, thus, micro enterprises can move to small business category, while small businesses can move to medium-size enterprises category, which is an important condition for improving economies of scale.

Based on the research, investment in knowledge- and technology-intensive industries increases innovation capacities that can also support reaching the level of Visegrád countries and the EU average.[54] In addition, the tendency of the number of patents registered yearly also provides

[53] If we examine the 10-year incentive EU expenditure appearing in the increase of capacities, which can be outlined in about HUF 40-50 billion, then, at a conservative estimate, it is likely that this investment will already show full returns in these ten years.

[54] According to the latest central bank report on our competitiveness, Hungary's innovation achievement lags behind the EU average, however it is at an appropriate level to the regional average. The GDP-proportional R&D expenditures in Hungary between 2008 and 2018 increased from less than 1 percent to over 1.5 percent, 0.2 percentage point above the

important feedback, shedding light on the fact that utilisation of higher R&D expenditure is low, not efficient enough. Targeted opening towards knowledge-intensive industries can be a step forward that can also be an effective stimulus to the development of digitalisation and digital technologies.[55]

Only an innovation-driven growth model can provide a framework for a state approach aiming for a sustainable growth path based on knowledge, capital and productivity. For which, the incentive state's role is essential in endeavours to increase R&D expenditures and R&D number of personnel. It should be noted here that The Central Bank (MNB, 2020) also draws attention to the importance of increasing R&D expenditures and the number of R&D personnel.

The concept of a motivating state model means the use of financial, supporting, organisational, condition-ensuring, educational and various social policy tools by which consciously and in particular direction, the state helps economic actors or a specific sector, such as space industry actors to achieve the goals, ensuring the harmony of community/social goals and entrepreneurial interests.[56]

Based on all this, today and during the coronavirus crisis, the following industrial characteristics especially justify the national economic relevance of the space industry that have been pushed into the background after the change of regime, but in recent years received more and more governmental attention. *(Table 4)*

Table 4: SPACE INDUSTRY AS A PERSPECTIVE INDUSTRY

Social embedding of achievements of technological development	**Sustainability aspects and harmony of the common good**	**Knock-on industrial effects, extensive corporate involvement and social utilisation**	**Crisis-resilience and lasting economic development**	**Necessity for state and market coordination**
Technological assets became part of our daily lives: ● smart phone, computer, ● GPS positioning, ● navigation,	● UN 2030 Sustainable Development Goals,[57] ● EU economy catalyser space industry goals,[58]	***Positive social and economic effects and extensive industrial benefits:*** ● health care, ● agriculture, ● high-tech industry,	● crisis-resilience of NPV in 2008 and 2009,[60] ● coronavirus	● importance of state's role, ● growing accord between state and market,[62]

performance of the other Visegrád countries that is encouraging. Nevertheless, the domestic target in 2020 was 1.8 percent, while the average in the EU was 2.1 percent. More details are available: Hungarian National Bank (2020), Competitiveness Report.

[55] E-solutions: e-commerce, e-administration, e-business development solutions, etc. are all solutions based on space technology.

[56] See details of the concept and role of the motivating state model: Motivating State – More Efficient Companies, Bianka Parragh (ed.) Akadémiai Kiadó, 2019

[57] To achieve the UN 2030 Agenda for Sustainable Development, the results so far can contribute to a number of points.

[58] Council of the European Union (2019): Strengthening Europe's role as a global actor and promoting international cooperation, space diplomacy and contributing to building the global space governance – Authoritative debate, document No. 8999/19., Brussels, 10 May 2019; and Council conclusions on "Space as an enabler" - Adoption, document No. 9248/19., Brussels, 17 May 2019

[60] Space industry can be considered a crisis-resilient industry. Between 2005 and 2017, the sector expanded by 6.7% that is almost double of the 3.5% world average. Moreover, during the financial crisis of 2007-2010, from year to year more than 3.5% growth rate was observed according to data of the European Investment Bank.

[62] Together with the Ministry of Human Capacities and the Ministry for Innovation and Technology, transformation of the training system in space research and space activities, its integration into primary and secondary education, harmonisation of the synergies among the training systems of higher education institutions involved have begun.

Table 4: SPACE INDUSTRY AS A PERSPECTIVE INDUSTRY				
Social embedding of achievements of technological development	**Sustainability aspects and harmony of the common good**	**Knock-on industrial effects, extensive corporate involvement and social utilisation**	**Crisis-resilience and lasting economic development**	**Necessity for state and market coordination**
● Satellite-based telecommunication, ● weather forecast, ● precision agriculture, ● climate protection, ● environment protection	● full use of the opportunities offered by ESA membership, ● basic law and social need in order to ensure common good[59]	● auto industry, ● education, ● green industries, ● R&D&I, ● international partnerships, ● international corporate collaborations, ● joining in global value chain, ● developing bilateral and multilateral diplomatic relations	crisis-resilience in 2020,[61] ● development across economic cycles	● targeted economy development and economy incentive realised in partnerships between the state and private sector, ● international collaborations[63]

Source: University of Public Service, Economic Implications Research Team, 2020

Greater emphasis may be placed on state incentives of new directions whose knock-on positive effects can be identified on a broad spectrum, and business models can be created based on the cooperation of state and private sector. Space industry fits well into this economic policy approach, as a prospective crisis-resilient industry encouraged by the State.

The characteristics and achievements of the domestic space sector can be considered remarkable even in relation to the level of public expenditures, where as a result of the state's role, broad growth reserves can be identified in the short, medium and long term.

[59] Promising initiatives in certain professional fields and Hungary's increasingly active international role also support a more complete domestic realisation of goals of the knowledge-based society and sustainable development, which can be framed in the context of the Constitution. In line with these commitments, space sector plays an important catalyser role between the three poles and goals of sustainable development: in particular among the industry, agriculture, transport, maritime transport, agrarian sector, and the agriculture, rural development, digitization, security, as well as defence.

[61] The achievement of space sector was close to EUR 300 billion in 2019 that is approximately USD 400 billion, and the processes in 2020 also indicate progress even in the conditions of covid-19 epidemic. The crisis-resilience and resistance of space industry is supported by the following study: PWC (2020): Resilience of the Space Sector to the Covid-19 Crisis,
More details: https://www.pwc.fr/fr/assets/files/pdf/2020/05/fr-france-en-resilience-of-the-space-sector-to-the-covid-19-crisis.pdf

[63] In the field of international collaborations, Hungary concluded international cooperation agreements with Brazil, Turkey, Singapore, Israel, France, Portugal and the US-based Virgin Galactic Holding by the Hungarian Ministry of Foreign Affairs and Trade in the period 2019-2020, in addition to which, significant progress has been made in multilateral relations, as well. In the period 2018–2020, Hungary has reorganised the Hungarian representation in the ESA, EU and UN expert task forces. Thus, today, national representation in the field of space research is ensured in the most important multilateral institutions.

GLOSSARY

Downstream: The services of "downstream" segment are responsible for ground communication of objects that includes all services and processing of information that can be extracted from the database provided by space objects. This includes activities based on space technology or using a system operating in the outer space that may lead to the creation of an application, product or service that results in social or economic benefit. Needs of the "downstream" segment induce the improvement and market access of the increasingly innovative, economical and up-to-date objects.

European Space Agency (ESA): ESA is a European intergovernmental organisation, however independent from the European Union that deals with the exploration and use of space. Currently it has 22 Member States. Canada cooperates with the organisation as an Associate Member.

ESA BIC (ESA Business Incubation Centre): It aims to create workplaces and to develop regional economies of the Member States through the ESA BIC Programme.

ESA BIC-TTO (ESA BIC – Technology Transfer Office): Since 2000, the ESA Technology Transfer Programme Office (TTPO) supports positioning the space-related business ideas in commercial enterprises, and provides technical expertise and business development assistance.

ESERO: ESERO is ESA's Education Programme. It aims to familiarise children in primary school age with space research and space activities through scientific subjects. This can contribute to eliminating the lack of knowledge in the field in Hungary, and to increasing its reputation and acceptance.

Earth Observation (EO): It is the general expression for activities that monitor the physical state of the Earth and its immediate surroundings and its changes. Weather and climate observations, geological assessments, measurements on biosphere, ground flora and fauna are included here. Typically, military intelligence, artificial objects or observation of human activities are also included in this area.

Geostationary satellites: The satellites launched on a geostationary orbit are called geostationary satellites (GEO satellites). Their importance is that they stand at one point on Earth in a fixed position (see Geostationary orbit).

Geostationary orbit: The orbiting period of celestial bodies 35,768 km above the Earth's surface is equal to the Earth's rotation period, thus, the satellites in this orbit are always stationary over a fixed position on Earth. Launching an object on this orbit is very expensive, however, it has a huge benefit, for example in case of telecommunication satellites, as this way, a satellite dish on Earth can be fixed to always stay pointed towards that satellite, and the data transmission is continuous.

Geo-return: It means territorial, geography-based return. The payments are returned based on a geographical return ("geo-return") principle, that is the payer state's companies and research institutes in space sector receive from the Member States' payments after deducting internal costs of the organisation. The geographical return principle is the ESA's special directive, based on it, each Member State is entitled to apply for a certain proportion of its payments through various projects of the given state's companies. Thereby, it is guaranteed that each Member State is concerned in increasing its own payments, as thereby, it supports its own economy.

Global Navigation Satellite System (GNSS): It is a general expression for all navigation systems that use satellites, the American GPS (Global Positioning System) is the best-known among them. The EU has the Galileo system, Russia has the GLONASS and China has the Beidou.

ICT sector: Information and Communications Technology sector.

Intercosmos Programme: A space programme initiated and lead by the Soviet Union that fostered the scientific cooperation between the Soviet Union and its allied states (later with Japan, France, the United Kingdom and Austria), making possible for the Eastern Bloc to participate in the peaceful conquest of the outer space. Bertalan Farkas, the first Hungarian astronaut was in the outer space as part of this programme.

MEO (Medium Earth Orbit): Medium Earth orbit comprises a wide range of orbits anywhere between GEO and LEO. Typically, MEO is an orbit of satellites that are planned for longer orbiting period, and it is not strictly specified, which geographical coordinates it should appear above. Medium Earth orbits are commonly used by satellites of various global navigation systems (such as GPS, Galileo, GLONASS).

Satellite services: All services are called satellite services that are based on satellite data. Main areas include earth observation, satellite navigation and satellite communication.

STEAM (Science, Technology, Engineering, Arts, Mathematics): It is a general expression for scientific subjects. The expression is similar, but not exactly the same with the Anglo-Saxon STEM umbrella term (Science, Technology, Engineering and Mathematics).

New Space: Outer space is part of a global value chain that is undergoing significant changes, expanding the traditional boundaries of the space sector. By the "New Space" phenomenon we understand primarily the changeover of space sector from traditional (based on state's role) value orientation to new business models under increased appearance of the private sector. The new activities created during the business / technological model changeover, as well as the activity serving for assessing competences of space actors, are generally called New Space diagnostics.

LEO (Low Earth Orbit): Most satellites can be found at an altitude of less than 1000 km but could be as low as 160 km above Earth. Unlike GEO satellites, LEO satellites do not have to orbit only along Earth's equator. Being near the Earth's surface and the fact that after a period of time, the objects in Low Earth orbit can get "above several points", these orbits are ideal as earth observation, scientific and surveillance satellites. As the unit cost of launching space objects is relatively low, often a constellation of more satellites accomplishes one task at a time. At the end of their life cycle, satellites in lower LEO burn when they enter the atmosphere, thus, space debris is not generated.

Upstream: The activities and services of "upstream" segment are responsible for launching the objects (up) in the outer space. Upstream is any activity that is aimed at creating a product (whether hardware or software) to be used directly in the outer space. For example: satellite and booster rocket manufacturing. The appearance of "downstream" services justifies the dynamic growth of upstream segment and its increasing market presence.

Space dosimetry: It is a branch of science that deals with the measurement of electromagnetic radiation in the outer space, its effects and neutralisation. There is a research team dealing with this subject in Hungary since 1970 that produces outstanding quality, internationally recognised equipment in the field. In the outer space, electromagnetic shield of the Earth does not protect either astronauts or electric equipment from cosmic radiation, therefore the current and exact measure of radiation is a cardinal issue.

Space economy: The space economy can be divided into two main segments: "downstream" and "upstream" segments. By space economy, we mean the services, activities of "downstream" and "upstream" segments, and the assets produced by these segments.

Space industry: Space industry is an economic sector whose production service profiles, economic interests, management solutions, relations are linked to the space economy and space sector.

Revenue of the space industry: Revenue from production, operation and maintenance of objects (satellites and other equipment), which are essential for the services of space sector.

Space research: By space research we mean the research and utilisation of solar system, as well as the planning and launching of space objects in orbit. The space research cooperates with several academic fields. As a branch of science, it is pragmatical compared to astronomy, and relatively quickly utilisable for the society. In a number of cases, astronomy relies on space objects, as physical, medical, pharmaceutical and chemical research, as well.
Space research is also able to open new possibilities for the economy in the short term. Experts and companies engaged in space research expand the utilisable physical space for the humanity, as the sailors crossing the ocean did in time of the great geographical discoveries, thereby they create new utilisation possibilities, new resources, new services and new industry serving this.

Space sector: All primary research, experimental, educational, organisational, manufacturing, service, space object production, launching in the orbit, celestial and earth observation, information technology, communication, infrastructural development and related management, international relations, etc. tasks are included in the concept of space sector, thus space economy that are related to the exploitation of space.

Space debris: It is cosmic waste in other words, all artificial objects are included here that are orbiting in the outer space, and they cannot be utilised and cannot be brought into working order. The problem with space debris is becoming more and more significant, as it disturbs the space activities around the Earth in a considerable measure. Finding a solution for it is the most current research developmental direction.

Space activities: By space activities we mean any activities that use and implement the results of space research. Telecommunications is the most evident, but not the only manifestation of practical economic and social benefits that derive from space activities using and implementing the results of space research. Developing satellite broadcasting is a process, according to which now greater emphasis is laid on space activities in the national space programmes than on classical, scientific space research, in other words on the exploitation of economic and national security aspects given by outer space.

Resilience: According to the concept developed by international organisations, in general sense, resilience means the ability to resist flexibly that is the capability of a system to adapt successfully to strong, recurring or even shocking external impacts.

Spin-off: Space research has developed a number of innovations that infiltrate in the market solutions in the narrow sense. These “spin-off” solutions are useful not only for the dynamically growing and significant space companies. For example, the revolutionary new solutions for velcro, teflon, several medicines (such as cardiac and osteoporosis medicines), solar collectors, purification of water, air filtering, automatization and miniaturization can be all used and utilised in many fields from the pharmaceutical industry to energetics.

TRL (Technology Readiness Level): An international classification has been developed to measure the technology readiness level that classifies the readiness level of projects into 9 levels. In order to provide users with information on technologies, which need longer developmental period, each component or unit can be classified into one of the 9 readiness levels, from the basic concept to the successfully

completed mission. This classification allows developing a complex programme, in which it is possible to track when the applicability of each new technology can be expected.

SUPPLEMENTARY CONCEPTS

Types of space objects:

- ***Space station:*** Orbiting a given celestial body, an object suitable for maintaining human life.
- ***Spacecraft:*** Moving in the interplanetary space, an object suitable for maintaining human life.
- ***Space probe:*** An unmanned object moving in the interplanetary space.
- ***Satellite:*** An unmanned space object orbiting the Earth in a fixed orbit. This category makes up the majority of space objects. It can be divided into the following categories:
  - Large satellites: >1000kg
  - Medium satellites: 500-1000kg
  - Small satellites: <500 kg
  - Minisatellites: 100-500 kg
  - Microsatellites: 10-100 kg
  - Nanosatellites: 1-10 kg
  - Picosatellites: 100g – 1 kg
  - Femto satellites: 1 – 100 g
- ***CubeSats:*** One unit that is 1U CubeSat is built up from standard cubic units each measuring 10 cm x 10 cm x 10 cm, weighing not more than 1 kg. By combination of these cubes, 1U, 3U, 6U, 12U and so on, further CubeSats can be created. The world's smallest operating satellites are the 5 cm x 5 cm x 5 cm size Hungarian Smog-P and Smog-1 PocketQube satellites.

Technology Domains (TD): Each technology is classified by a so-called Technology Domain, thus space agencies and clients get information about which areas the individual companies (their prospective suppliers) are competent in. Based on ESA's definition, 26 areas can be differentiated, for example electrical power supply (TD 3), ground stations (TD 12) and thermal control (TD 21).

Phases of a project life cycle:

The progress of each mission can be determined with the life cycle phases that are also used by the European Space Agency. On this scale, each programme can be classified into one of the six (in some cases seven) phases, from the conceptual outline to post-mission review. These phases are not sharply separated from each other, that is certain activities of the project can overarch, however, completion of a given phase is always linked to a strict requirement that is usually the submission of a review document. These phases are the following:

- ***Phase 0 and Phase A:*** Defining mission and feasibility analysis are in progress, this phase is closed with the Preliminary Requirement Review (PRR).
- ***Phase B:*** Preliminary planning is completed, exact set of requirements is clarified, and developing the most time-consuming components has started. This phase is completed with the Preliminary Design Review (PDR) document.
- ***Phase C:*** Elaboration of detailed plans that is completed with the Critical Design Review (CDR) document.

- ***Phase D:*** Manufacturing last components of the objects, as well as qualification and verification for space environment are in progress in this phase. Its final document is the Flight Acceptance Review (FAR).
- ***Phase E:*** Operation and use of objects is in progress, this phase is completed with the End of Life Review (ELR).
- ***Phase F:*** Mission is evaluated and completed with the Mission Close-out Review (MCR).

Supply chains:

Complex supply chains have been formed for the production of complex and high-quality objects in this field. In order to define the role of suppliers in each mission, a routine has been developed, that is each partner is classified into one of 5 levels. It shows how much the project depends on the given company. These 5 levels are the following:

- ***Tier-1:*** ("Prime") Suppliers of direct, complete objects, such as satellite or launch vehicles are located at this level.
- ***Tier-2:*** Those partners are located at this level who supply main parts, subsystems of the given objects. In case of satellites, such subsystem is for example the communication, data handler, thermal or power submodule.
- ***Tier-3:*** Those suppliers who manufacture critical components of these subsystems can be located here. Such as turbine-pumps of rocket engines or satellite accumulators.
- ***Tier-4:*** These suppliers produce critical components, typically solar collectors, amplifier electric circuits or accelerographs.
- ***Tier-5:*** Hardware and material suppliers who produce feedstock (i.e. Hydrogen) or basic components (bearings and bolts) are included at this level.

Acronyms

ESA: European Space Agency

ESA-BIC: ESA - Business Incubation Centre

ESA-BIC-TTO: ESA-BIC Technology Transfer Office (TTO), ESA-BIC Technology Transfer Programme Office (TTPO)

ESERO: European Space Education Resource Office (ESA's Education Resource Office)

EUSPA: European Union Agency for the Space Programme

FIR: Earth Observation Information System

FOK: Earth Observation Operative Centre

MANT: Hungarian Astronautical Society

GSA: European Global Navigation Satellite Systems Agency (European GNSS Agency)

MNB: Hungarian National Bank

ITM: Ministry of Innovation and Technology

EMMI: Ministry of Human Capacities

IM: Ministry of Justice

PM: Ministry of Finance