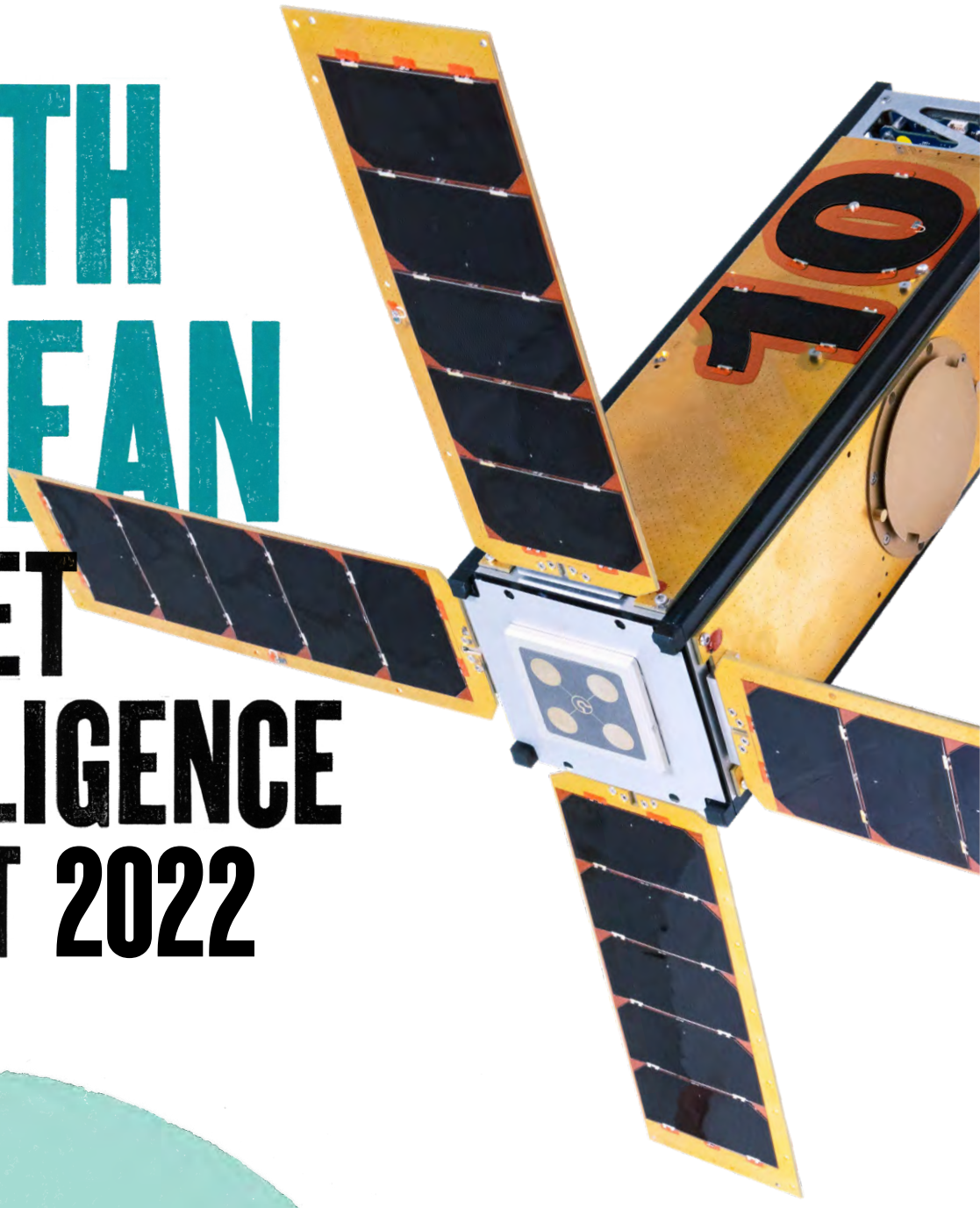
Department for International Trade

SOUTH KOREAN MARKET INTELLIGENCE REPORT 2022



Space

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Department for International Trade

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01 INTRODUCTION

South Korea[1] is making major investments in its space industry with the goal of becoming a leading global power in the arena. Having only successfully launched its first fully domestic rocket in 2021, the country is now seeking to achieve lunar orbit this year and an unmanned lunar mission by 2030. Korea is racing to catch up with its regional peers in the number of military satellites deployed and is rapidly accelerating technology transfer from the public to the private sector as the industry is increasingly viewed as a strategic imperative, both in economic and in security terms. The Korea Positioning System (KPS) project, a GBP 2.2bn initiative that would make Korea only the 7th country in the world to have its own satellite navigation system, highlights the county's ambition in the rapidly developing domain of space.

[1] This report uses Korea to refer to South Korea except where clarity requires the latter.

The Korean space industry has grown at an average of 17% over the past 10 years to reach an estimated GBP 2.1bn as of 2020. Major defence contractors Korea Aerospace Industries (KAI), the Hanwha Group and LIG Nex1 dominate the industry, but there are new entrants in Hyundai Motor Company and Korean Air alongside a host of SMEs and start-ups. Companies are entering the space market spurred by a strong emphasis on localisation and privatisation. A key part of the new growth created by space development is the KPS project, which is expected to have a huge impact beyond space to sectors such as autonomous vehicles and drones.

Korea's security environment necessitates robust defence capabilities and space defence is increasingly becoming a priority for the government. The Ministry of National Defense (MND) announced a 10-year, GBP 9.9bn project to improve its capabilities in space, chiefly focused around intelligence, reconnaissance and communications satellites. The Korean military is also developing long-range missiles using solid state rocket fuel in a public-private project led by the military's R&D agency and local defence contractors. The new government of President Yoon Suk-yeol, which will assume office in May 2022, is expected to place an even greater emphasis on space defence capabilities.

The national space R&D budget in Korea of GBP 455m for 2022 is relatively small considering the government's ambitious targets. Approximately 75% of the budget is focused on developing launch vehicles and satellites, but this may not be enough considering the number of large projects being planned. Space R&D funding tends to focus on large projects supporting national strategic objectives, but there has been movement in recent years towards smaller projects focusing on basic space science and research.

The Korean space market represents opportunities for UK players with technologies that can help meet government and key private sector companies' objectives. Local players continue to advance in capabilities, but projects such as the 2030 lunar mission are likely to create room for companies or organisations overseas that can supply specialised launch, satellite platform or payload technologies. R&D collaboration or technology transfers may be more suitable given the government's strong emphasis on localisation. Companies seeking to enter the Korean space market are advised to collaborate with a local partner to better understand opportunities and the procurement process, particularly for government-led projects.

SWOT ANALYSIS

Strengths

- Ambitious space programme seeking to become a leading global space power
- Making significant investments to achieve lunar mission by 2030, primarily through domestic capabilities
- Investing GBP 2.2bn in 14-year KPS project to become 7th country with indigenous satellite navigation system
- Investing GBP 9.9bn in defence satellite capabilities, improving internal coordination on broader space defence capabilities
- Major aerospace and defence players looking to space as a new area of growth

Weaknesses

- Relatively small space budget of GBP 455m compared with Japan (GBP 1.9bn), India (GBP 1.4bn) or China (GBP 8.1bn)
- Lags regional powers in space defence capabilities, e.g. 22 military satellites versus 391 for China, 184 for Japan and 99 for India
- Local defence and aerospace players still playing catch-up technologically
- Reliant on foreign solutions from the US or EU regarding core technologies for satellite communication and thrusters
- Limited investment in basic space science R&D and areas outside of national strategic focus

Opportunities

- Security environment on Korean peninsula and regionally within Northeast Asia is likely to spur greater demand for space defence capabilities
- Incoming administration signalling greater role for defence within space policy
- Small space R&D spending, along with ambitious goals, creates opportunities for overseas players to supply in-demand technology or for government R&D collaboration
- Growth of private sector in space industry could represent B2B opportunities

Threats

- Government emphasis on localisation limits opportunities for overseas companies to join large projects
- Longstanding security partnership with United States favours American companies and solutions, particularly related to defence
- R&D collaboration opportunities limited by size of funding for basic science projects, affinity for institutions in the US and EU
- Complex government procurement process difficult to negotiate from overseas

02

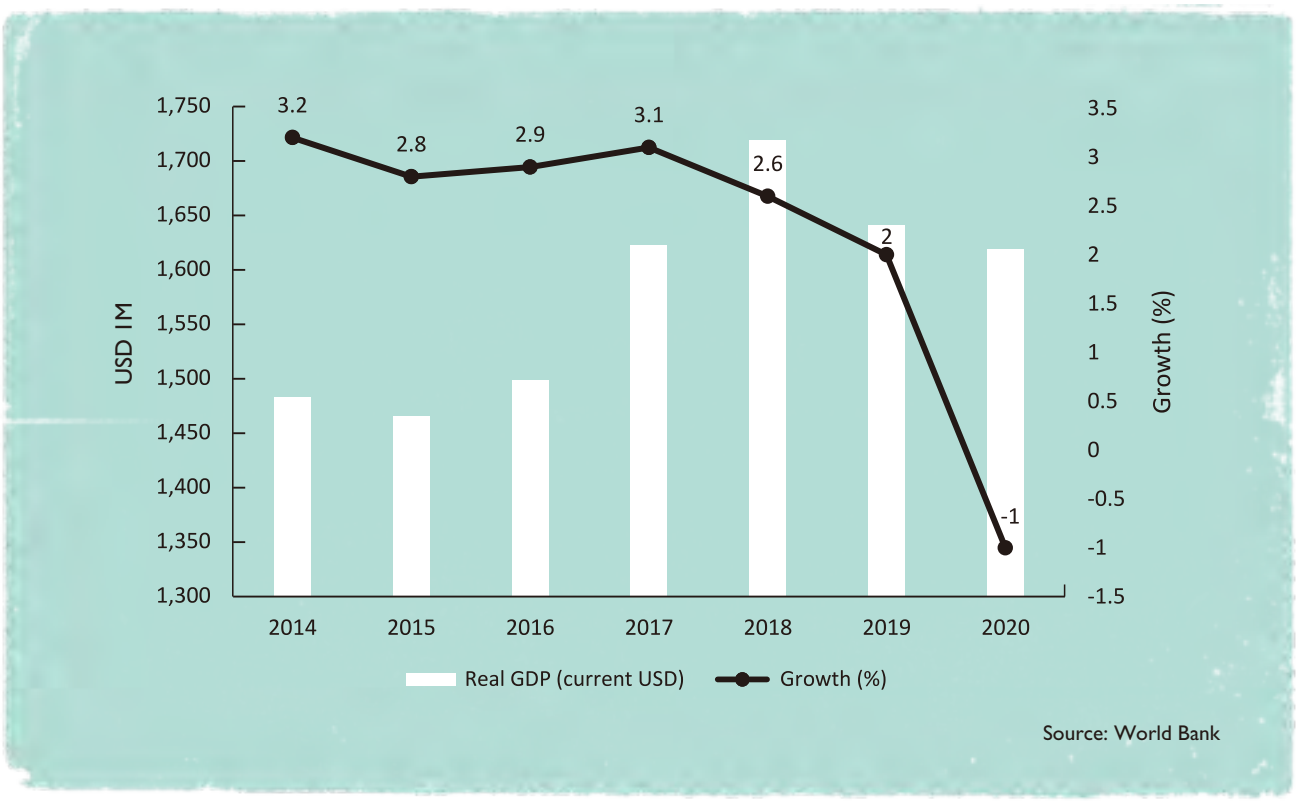
KOREA: AN OVERVIEW

In the space of just 60 years, Korea has transitioned from an agricultural economy to one driven by high value industries such as automotive, shipbuilding and advanced manufacturing. Perhaps most remarkable of all is the country's success in the area of information communications technology where it has become world class in terms of semiconductor, consumer electronics and ICT infrastructure.

With a population of 51 million people, Korea boasts the 10th largest economy in the world, a GDP of GBP 1.21 trillion (USD 1.63 trillion) in 2020 and a per capita GDP of GBP 23,300 (USD 31,500) that same year. Whilst no longer experiencing the dizzying growth rates that characterised its early growth phase in the second half of the twentieth century, Korea has maintained strong growth for a developed economy of close to 3% in the years prior to the outbreak of the COVID-19 pandemic.

Total trade (exports and imports) between the UK and Korea was GBP 13bn in the four quarters to the end of Q2 2021, an increase of 6.1% or GBP 749m over the preceding 12-month period. Of this, UK exports to Korea totalled GBP 7.5bn while its imports from Korea came to GBP 5.5bn. Korea is the UK's 22nd largest trading partner and accounts for 1.1% of total UK trade. The UK and Korea signed a continuity free trade agreement in 2019 which largely replicated the EU-Korea agreement.

Figure 1: GDP and growth rates (2014-2020)



03

GOVERNMENT STRATEGY & DIRECTION

BACKGROUND

The Korean space programme dates back as far as the 1970s when the military began the development of ballistic missiles. However, this stopped in 1979 when Korea accepted a limit of 180 km on the range of its missiles in exchange for continued access to US missile technology. A real space programme began in the 1980s with the passing of a law promoting the development of a domestic aerospace industry in 1987, and the subsequent establishment of the Korea Aerospace Research Institute (KARI), the public research institute for Korea's space development.

The space programme started to yield results in the 1990s as KITSAT-1, Korea's first satellite, was launched in 1992, followed by KITSAT-2 in 1993 and KITSAT-3 in 1999. Korea launched its first three commercial satellites between 1995 and 1999, used for communications and broadcasting. KOMPSAT-1 was the first domestically produced satellite and was launched in 1999 carried by an American rocket.

Launch capability became the next goal of the country's space programme. KARI developed single and two-stage sounding rockets (KSR-1 and KSR-2) between 1993 and 1998. The 2002 launch of KSR-3 marked an important milestone with its use of a liquid propulsion system. Government plans after the KSR-3 started to look towards acquiring launch capabilities beyond sounding rockets that could put a satellite in orbit, the satellites of the 1990s having relied on American, Russian, French and Japanese rockets.

The 2002 opening of the Naro Space Center marked another major step as the satellite launches took place in Korea for the first time. The satellites of the 1990s had used launch sites overseas, predominantly the US and the EU. The Korea Space Launch Vehicle (KSLV) project, first announced in 2002, saw the launch of the Naro rocket (KSLV-I) in 2009. The first launch failed, as did the second in 2010, but a successful third launch in 2013 achieved earth orbit. The successor to the Naro rocket is the Nuri rocket (KSLV-II), which saw its first launch in October 2021 and used a locally produced first stage, unlike the Naro rocket.

"Korea has shown tremendous growth in the last 20 years and can be expected to catch up to the global leaders in just a matter of time."

President, Korea Society for Aeronautical & Space Sciences

Korea has made impressive progress in space over just 30 years, but the next 10 years promises to see this progress accelerate even further. Korea plans to achieve lunar orbit in 2022 with a second launch of the Nuri rocket, begin a 15-year project to develop its own satellite navigation system known as the Korean Positioning System (KPS), and achieve an unmanned lunar landing by 2030. Its military meanwhile will develop its own solid fuel rockets and satellites to guard against North Korea. All of these projects, the government hopes, will build the capabilities of Korea's private space companies, who will also develop new technologies and services, turning space into a new growth engine for the Korean economy.

TRENDS AND AMBITIONS

Korea has an increasingly ambitious space programme that has progressed from the time it first joined the small group of countries with domestically developed satellite launch capability, to developing its own lunar orbiter and, ultimately aims to send a mission to the moon. Korea's space ambitions are driven by the desire for a larger role on the global stage, the role of technological development as a growth engine in national economic policy, and a security environment that requires paying attention to space.

Korea has emerged as global middle power in recent years and gained attention for its strong handling of the COVID-19 pandemic. Successive Korean governments have seen the development of technology as crucial to its continued economic growth, a policy that has proven to be successful in industries as diverse as shipbuilding, automobiles, displays and AI. In recent years, the government has made significant investments in the development of emerging technologies, betting that its GBP 102bn package of investments known as the Korean New Deal will create new growth industries the country.

Korea is not a leader in space development: one government estimate suggests Korea lags between 10 and 20 years behind the US in terms of space technology capabilities, with its overall technical capability currently estimated to be just over 50% that of the US. However, the Korean government is determined to close that gap in a hurry with a view to not only becoming one of the leaders in space exploration, but also in the development of a private sector space economy where the civilian sector leads space development while also identifying new business models and commercial services. Plans are underway to transfer government-held technology to the private sector in order to facilitate this, although updated infrastructure and regulations will also be necessary.

Space development in Korea is also fuelled by a drive for autonomy and self-sufficiency, which are the self-stated goals of the space programme. Whereas Korea had collaborated with overseas partners to develop its first satellites and launch vehicles, part of the success of the Nuri rocket launch in 2021 was its status as a rocket designed, manufactured, assembled and launched in Korea from mostly domestic suppliers. The importance of local companies developing or acquiring necessary technologies is likely only to grow in the future for the 15-year Korea Positioning System (KPS) project or the 2030 lunar mission.

Due to the circumstances of its foundation, Korea has always had a relatively large military but in recent years, its defence capabilities have come to the forefront thanks to steadily increasing budgets and rapidly increasing exports from its defence primes. It is natural, therefore, that South Korea would also seek to become a military power in space, driven by necessity due to the continued threat from the North. Satellites allow for the monitoring of the North Korean nuclear programme and troop movements, but South Korea has long been lacking in this area, particularly in comparison with regional powers China and Japan and so the country has launched a major defence programme to manufacture and launch military satellites produced by its own defence contractors.

Greater autonomy also figures into Korea's efforts to improve its space defence capabilities and reduce its reliance on the US. Support for developing nuclear weapons has increased in recent years, polling at over 70% in early 2022. Korea's space security goals overlap significantly with its broader national security goals of defence autonomy through the development of local technologies and capabilities. The elimination of the Revised Missile Guidelines agreement from 1979 paved the way for Korea to develop long-range missiles and to use solid state rocket fuel, technologies that will immediately benefit the launch vehicles and satellites in its space programme, but also allow for the development of more powerful weapons in the long term.

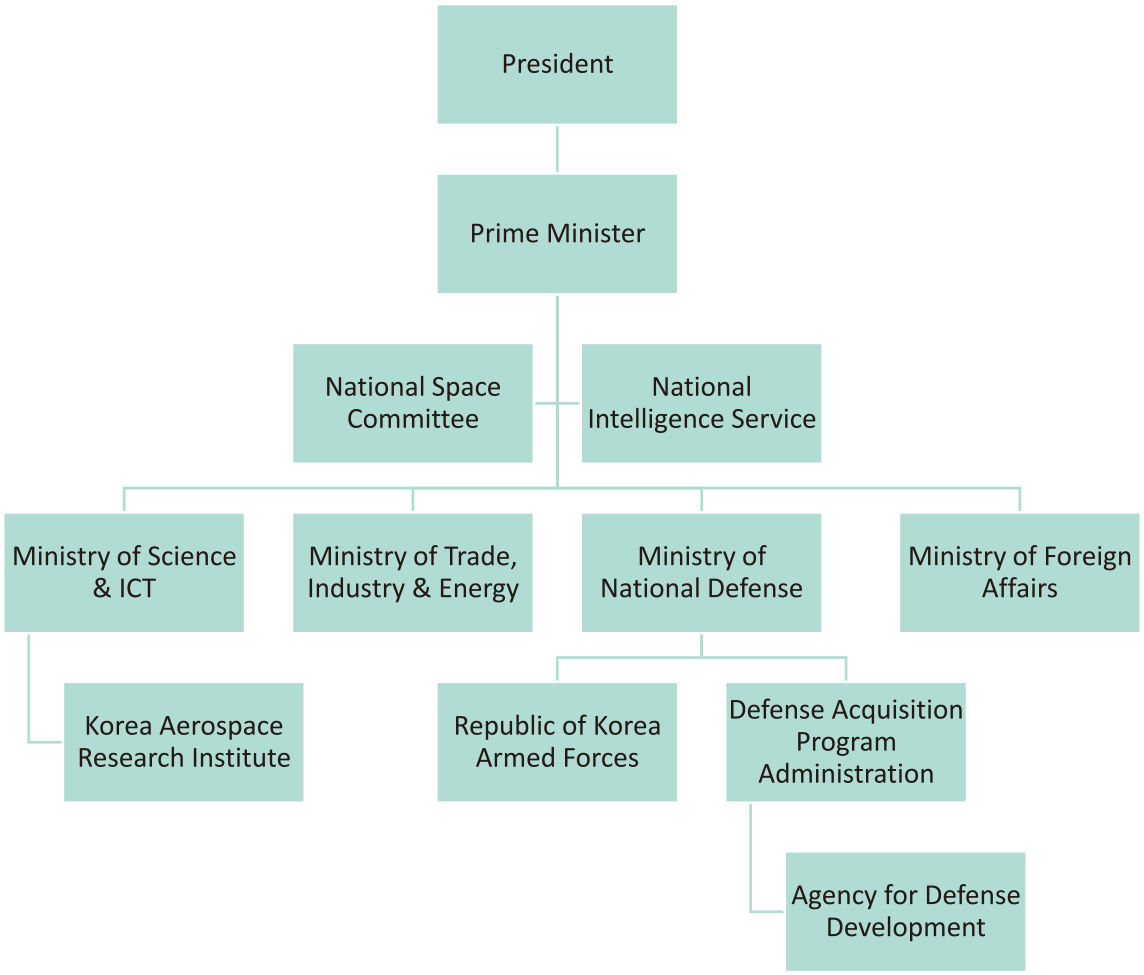
"The Korean government prefers utilising ITAR-free products for domestic launchers, which means European companies have a strategic advantage over products from the US."

Team Leader, major Korean defense contractor

KEY GOVERNMENT BODIES

KARI, a public research institute under the Ministry of Science and ICT (MSIT), handles space-related R&D while policy and decision-making are handled by a number of government bodies, most notably the MSIT and the National Space Committee (NSC). As a result, responsibilities for space development sometimes overlap, while limiting progress due to the absence of a coordinating body dedicated to space. The creation of a space agency has gained support from lawmakers and the new Yoon Suk-yeol administration.

Figure 2: Korean government space programme organisational chart



Source: Intralink research

The MSIT plays a large policymaking role, oversees the development of key technologies, and the allocation of funding for projects such as the KPS and the 2022 Space Challenge. The Ministry of Trade, Industry and Energy (MOTIE), meanwhile, is handling the transfer of space technology from the public sector to the private sector as the government body responsible for setting industrial policy. The Ministry of Foreign Affairs (MOFA) engages in Korea's space diplomacy and international cooperation related to space, as was the case with the 2021 Space Diplomacy Forum.

"Traditionally, the space sector was led by the Ministry of Science and ICT, but recently other ministries have shown interest in space as well. The Ministry of National Defense, along with the Ministry of Trade, Industry and Energy, are now looking to space and allocating budgets as well."

Professor, Department of Aerospace Engineering, Chungnam National University

The NSC was created by the 2005 Space Development Promotion Act and reports directly to the president. It is responsible for coordinating decision-making and policy across multiple government bodies, balancing scientific, industrial and military priorities. The current members are representatives from different ministries, including the MSIT, MOFA, MOTIE, Ministry of National Defense (MND), as well as the National Intelligence Service (NIS). The Committee was chaired by the MSIT minister, but in order to improve decision making capacity, the role of chair was elevated to the Prime Minister in 2021.

The MND leads the development of space defence technology. The Defense Acquisition Program Administration (DAPA), the procurement agency for all branches of the Korean military (Republic of Korea Armed Forces, ROKAF), regards technologies such as solid-fuel rockets as central to improving the country's overall defensive capabilities. DAPA has directed the Agency for Defense Development (ADD), a defence R&D institute under DAPA, to develop this technology. The Korean military is taking an increasingly strategic view of space and as of 2022, established a coordinating body within the Joint Chiefs of Staff, the Military Space Branch, to manage space defence capabilities that until now had been developed and operated by different branches of the military.

GOVERNMENT INITIATIVES

The Nuri rocket project, along with its predecessor Naro which saw three launches between 2009 and 2013, remains the most high-profile government space initiative. The Korea Space Launch Vehicle-II (KSLV-II), as the Nuri rocket is officially known, marked a major win for the Korean space programme as the first domestically produced rocket, using local technology for all three stages in a GBP 1.24bn project. Although Nuri failed to deliver its payload into orbit in October 2021, the successful launch marked an important milestone for the country's space programme. A second launch in June 2022 will aim to put a 168 kg satellite into orbit.

Table 1: Major Korean government space projects

Project	Goal	Timeline	Budget
Nuri rocket	Lunar orbit	2022	GBP 1.24bn
Space defence capabilities	Develop and manufacture space defence capabilities, including reconnaissance and communications satellites	2021-2030	GBP 9.9bn
Lunar mission	Unmanned robotic exploration of moon via locally developed rocket	2030	TBD
Korea Positioning System	Develop local satellite-based positioning, navigation and timing system	2022-2035	GBP 2.2bn

Source: Intralink research

Space exploration is the next step for Korea's space programme after developing satellite and launch capabilities. Plans for such a mission have been around for years and originally targeted 2025 for a lunar landing. In 2021, President Moon Jae-in set a target of a lunar mission by 2030, carried out by a locally produced probe and rocket. The Korea Pathfinder Lunar Orbiter (KPLO), set to be launched in August 2022 using a SpaceX launch vehicle, will be a first step towards this goal. The orbiter will survey the moon to better understand resources that exist there, while also identifying potential landing sites. However, the 2030 lunar mission will make use of an upgraded version of the Nuri rocket to deliver a lunar lander.

The Korean Positioning System (KPS) is another major project that would make Korea only the seventh country in the world to have its own satellite navigation system by 2035. Regional powers China and Japan have the technology, as do the United States, EU, Russia and India. Set to begin in 2022, the KPS will be the largest project in the history of the Korean space programme with a budget of GBP 2.3bn over 14 years. The funding would come from the MSIT, which has been planning the project since 2018.

The project will consist of eight satellites, the first launched in 2027. Trial services would begin in 2034 and full service is expected to start in 2035. The main benefit of the KPS would be to reduce the error range by more than 1,000 times in comparison to GPS, from an upper limit of 20 metres to 5 cm. It is hoped that this will give a boost to the commercialisation of autonomous vehicles and other innovative technologies that require precise location information. The economic benefits are expected to be significant, with the MSIT predicting the project will create 60,000 jobs and almost GBP 5bn of economic activity for the local space industry.

The Korean military is also actively looking at space defence, announcing plans in 2021 to invest GBP 9.9bn by 2030 in order to boost its capabilities in this area. The funding from the MND will include approximately GBP 31m in support for start-ups with space defence technology, as well as support for graduate programmes related to space defence.

A particular priority is developing solid fuel rocket technology that will allow Korea to sharply increase its number of communications, intelligence and reconnaissance satellites. This capability is significant given the unique security challenges posed by North Korea, both in terms of its own nuclear and missile capabilities, as well as conventional military threats and troop movements. The solid fuel rocket project, led by DAPA, consists of 24 core technologies that would be developed in tandem by the Agency for Defense Development (ADD) and private companies. To facilitate this, the ADD will transfer the solid fuel rocket technology it has already developed to local defence contractors and hopes to be able to have the first satellites launched within the next 4-5 years.

REGULATORY ENVIRONMENT

Korea established the Aerospace Industry Development Promotion Act in 1987 with the goal of creating a domestic aerospace industry. Tangible results took time given the complexity of the industry, but Korea now both produces and exports military aircraft, as well as their platforms, components and systems, in addition to having a space programme with domestically developed launch capability.

The 2005 Space Development Promotion Act built on the early progress made in the 1990s by creating a regulatory and policymaking framework to support Korea's space development. The law binds the government to explore and develop space in accordance with international norms, and to do so peacefully. The legislation also sets out processes for the issues arising from a growing space programme, such as the registration of space objects, licensing of space vehicles, and compensation and rescue in case of accidents.

A key feature of the Space Development Promotion Act is requiring the government to develop a Basic Plan for space every five years. The third and most recent plan was released in 2018 by the MSIT and called for several medium and long-term projects currently in progress, including a locally developed launch vehicle, lunar mission and the KPS. Overall, the plan identifies five key strategies: acquiring launch capabilities, further developing satellite services, lunar exploration and developing a local space industry.

Regulatory support for the development of the domestic space economy is also included in the 2018 Basic Plan, which sets a target of supporting the development of companies seeking to commercialise space technology, as well as the creation 1,500 jobs in the industry by 2022. Regulatory changes have also been made to facilitate the transfer of government technology to the private sector, such as royalty exemptions when participating in government projects, but it is understood that more work is needed to support the development of private space centres, as well as the easing of limitations on test launches.

INTERNATIONAL ENGAGEMENT

Korea is one of 111 countries to have signed the 1967 Outer Space Treaty, which underpins international space law. In addition to the Outer Space Treaty of 1967, Korea has also signed other major agreements governing space such as the Rescue Agreement of 1968, the Liability Convention of 1972 governing damage caused by space objects and the Registration Convention of 1975, which mandates a registry of objects launched into space.

In May 2021, Korea became the 10th country to sign the Artemis Accords, signalling closer cooperation in space development with the United States, as well as its support for a US-led effort to further develop international norms related to space exploration and resource utilisation. The exact nature of Korea's role within the Artemis programme, which seeks to send a manned mission to the moon by 2025 and establish a permanent lunar presence by 2028, remains to be clarified, although the existence of an international base on the moon will support Korea's ambitions for lunar exploration.

In addition to multilateral agreements, Korea also has strong bilateral relations on space with many countries, including the US, EU, Russia, China and Japan. The EU, UK, Japan and Russia have made varying contributions to the development of the Korean space programme including providing launch sites, launch vehicles and knowledge sharing. Strong Korea-US relations extend to space and this is likely to grow in the future through NASA's Artemis programme, as well as the close cooperation between the US and Korea on space defence.

The Korean Air Force signed an agreement for a Space Security Partnership with the US Space Force in 2021 with the goal of deepening cooperation related to space security. The agreement will include the exchange of both information and personnel, technical cooperation and joint drills. The agreement builds on the early stages of cooperation between the two countries related to space security, which already includes the sharing of space data from the US Space Force, as well as the inclusion of a small number of US Space Force personnel within US Forces Korea (USFK), the joint command for all US troops in Korea.

"To become a leader in space, South Korea needs to initiate projects like the Artemis Accords to encourage international space cooperation that will also bolster domestic space capabilities."

Professor, Department of Mechanical & Aerospace Engineering, Seoul National University

THE NEW ADMINISTRATION

Korea's President-elect Yoon Suk-yeol, who won the presidential election on March 9, 2022, is not expected to make any substantial changes from the space policies of the previous Moon Jae-in government, particularly in areas related to the privatisation of the space industry and high-profile initiatives such as the 2030 lunar landing. The day after the election, the incoming Yoon administration announced it would move forward with the creation of a dedicated space agency, as promised during the election by both main candidates. The new agency is expected to be located in Sacheon, approximately 350 km south of Seoul and home to a significant aerospace cluster.

One important signal of the government's attitude towards space will be how the new space agency fits within the government's overall organisational structure. KARI is a research institute under the MSIT, but the new space agency could be positioned within the MSIT, MOTIE or even the MND, representing the competing priorities of science, industry and defence. There is also a possibility that the new agency would be managed directly by the office of the president in order to better manage these competing priorities.

The conservative Yoon administration is expected to differ from its predecessor in placing a greater emphasis on the role of defence capabilities within its broader space strategy, in keeping with its expected harder line towards North Korea. To deepen the connection between the military and space R&D programmes, President-elect Yoon has pledged to move the military procurement agency DAPA from suburban Seoul to the central city of Daejeon, where both ADD and KARI are located.

A better understanding of how the Yoon administration will manage Korea's space programme will emerge in the summer of 2022 after Yoon takes office in May. It may be that President Yoon's emphasis on defence within space creates more opportunities for UK companies, including FDI as Korean defence contractors seek to bolster their capabilities. At the same time, a shift could also mean less opportunities for R&D collaboration as space budgets move towards defence and dual-use technologies and away from basic R&D.

"Currently there is no agency within the government that focuses on space policy. Each ministry has its own strategy with a separate budget. It is time for the Korean government to create a national space agency to promote cooperation both domestically and internationally."

Senior Manager, Korean aerospace and defense company

04

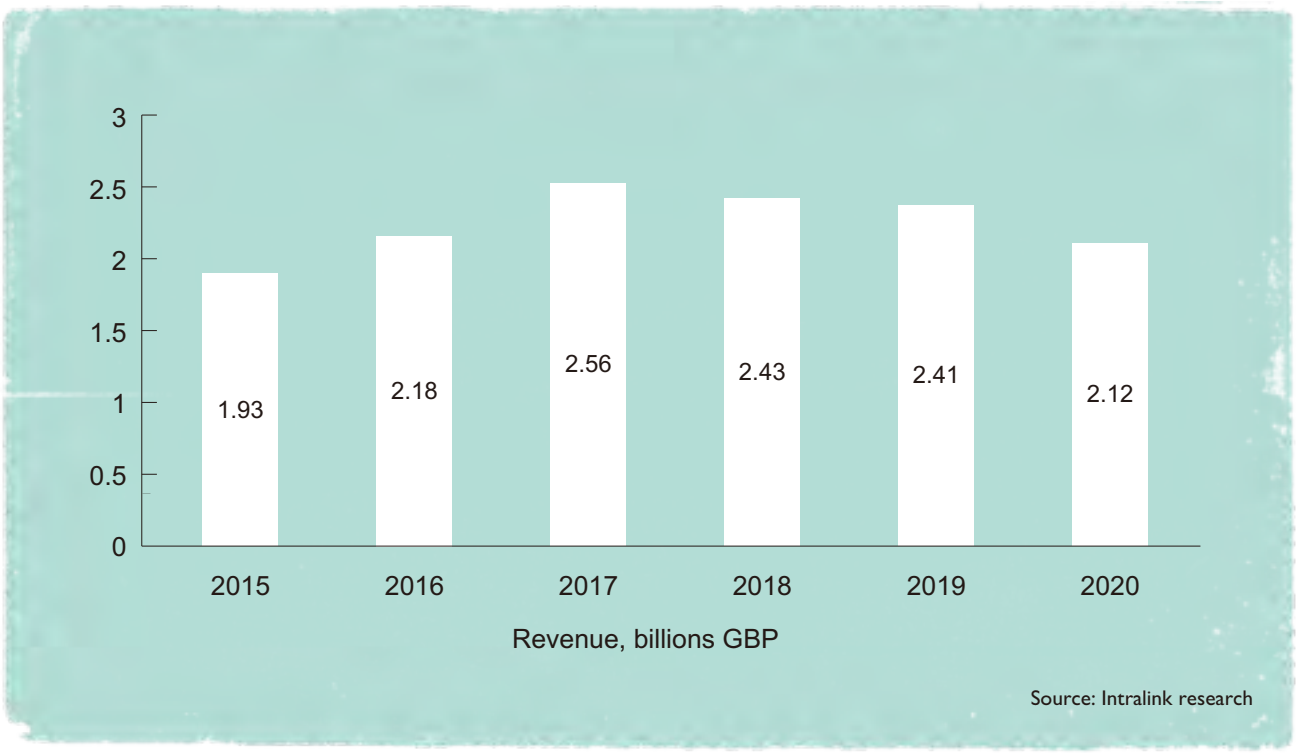
SPACE MARKET OVERVIEW

BACKGROUND

In 2020, the size of Korean space industry was estimated to be GBP 2.1bn based on data from the MSIT, representing just under 1% of the GBP 273.5bn global space industry. Korea's space industry lags behind countries such as Japan (GBP 7.86bn), India (GBP 5.3bn) and the UK (GBP 16.6bn), but the industry has grown rapidly at an average CAGR of 17% since 2010, when it was worth just GBP 489m.

The majority of the worldwide growth in the space industry over the past 10 years has been the result of increased demand for satellite services, and Korea follows this trend. Analysts predict that the global space industry could reach GBP 759bn by 2040 and even if Korea only maintains its 1% share of the global space economy – a conservative assumption – the local industry could triple in size by 2040 to GBP 7bn.

Figure 3: Size of Korea's space industry, 2015-2020



Source: Intralink research

The space industry in Korea can be broadly divided into manufacturing and space applications. Manufacturing takes up 38% of the industry and can be broken down into satellite (18.4%), launchers (12.6%) and ground stations (6.0%). Space applications, which utilise equipment produced by the manufacturing sector, account for 62% of the local space industry, almost entirely from satellite services (59.7%) that provide navigation and communication via satellite signals. The remainder consists of space exploration, rare mineral mining and scientific research.

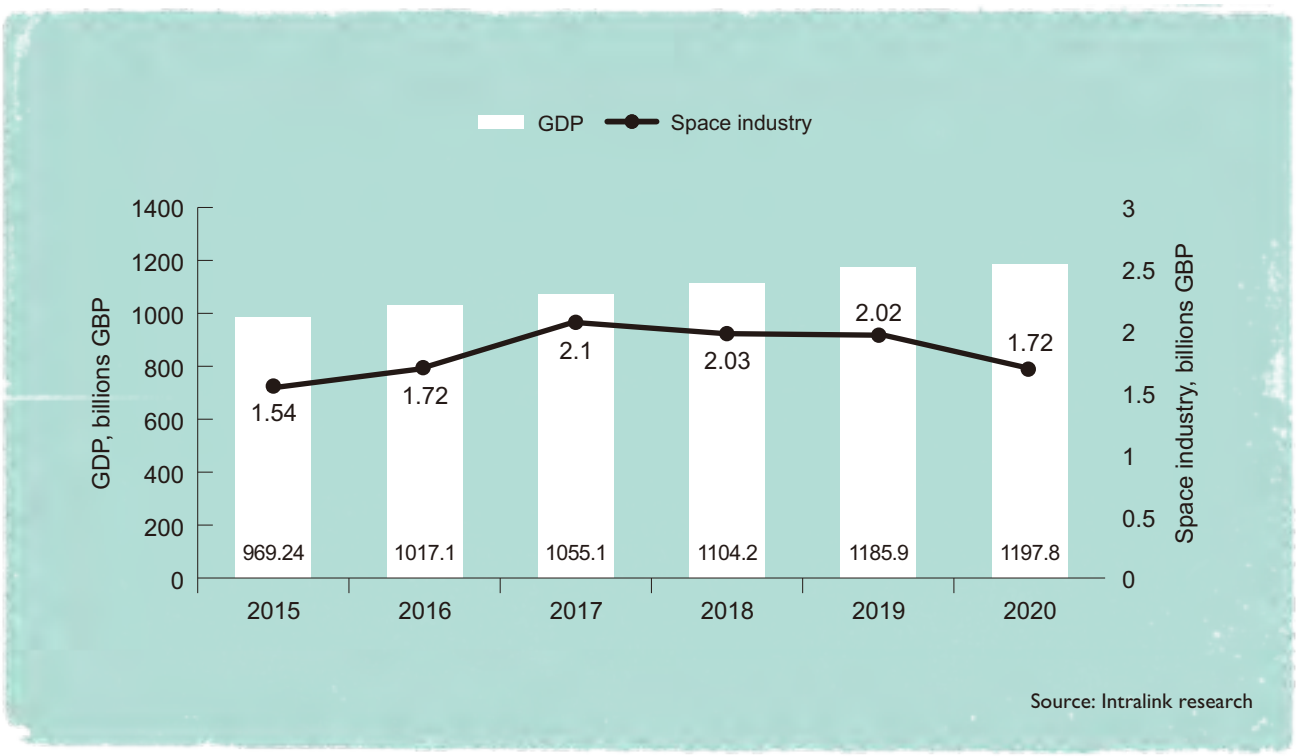
"For Korea to lead the space industry in the future, it first needs to identify potential threats in space looking 2-3 decades ahead. Korea needs to come up with creative solutions to address these issues and work with foreign governments and international players in space to move to the next level."

Executive, Israeli aerospace manufacturer

As of 2020, there were 389 companies in the local space industry, up from just 61 in 2010, and the number of people working in the industry has also grown to 6,305. Just under half of all companies (165) are in the satellite services and equipment segment, followed by ground station (87), launcher manufacturing (84), and satellite manufacturing (62). Two-thirds of all companies (65.6%) are SMEs with annual revenue below GBP 616m, while the 31 companies with more than 300 employees make up 42% of the industry by revenue. Geographically, although the South Gyeongsang province is known for its strengths in the aerospace industry, the majority of companies (209) and two-thirds of the economic value (69.8%) in the space industry are located in the greater Seoul area.

Korea exported GBP 423.4m worth of space related products in 2020, most of which (92.2%) were sales of satellite services, set-top boxes and antennas. In the same year, Korea's imports stood at GBP 97.2m, largely satellite components from other parts of Asia (56.8%) and North America (24.2%). Throughout the year, 24 companies registered 52 patents both domestically and internationally.

Figure 4: Korea's space industry as a percentage of GDP



Source: Intralink research

TRENDS

Localisation

Localisation, defined as a product with 80% of its parts and technology sourced domestically, is the dominant trend in the Korean space industry. Korean companies have significantly advanced their technical capabilities over the past 10 years, bringing Korea much closer to the government's goal of relying almost exclusively on domestically developed space technologies, materials, and parts. The government is making significant investments in R&D, while encouraging the private sector to do the same through government-funded research programmes and national initiatives, in order to meet its ambitious targets of achieving the capability to independently launch satellites and embark on lunar exploration.

Korea has invested heavily in R&D over the past 10 years while companies have made significant technological gains in core parts of launchers such as liquid-fuel engines. As a result, the demand for and role of outside solutions has decreased significantly. The Nuri rocket launch marked a major step for the government given the role of approximately 300 domestic companies in its design, manufacturing and launch. Despite of such efforts, Korea lacks sensor and payload technology, which is considered as core technology for further advancement of the industry.

New Space

The transition from a government-dominated Old Space to a New Space driven by the private sector is underway in Korea. Although Korea is several years behind in adopting the idea of New Space in initiating this transition compared to global players in the US or Europe, major defence and aerospace manufacturers such as Hanwha Aerospace and Korea Aerospace Industries (KAI), as well as relative newcomers in Korean Air and Hyundai Motor, see space as offering opportunities for new growth. The increased importance of space for defence purposes also attracts the attention of the country's leading defence contractors.

"In Europe and the US, New Space is leading the Old Space. In this new era of space, the Korean government should focus on investing in state-of-the-art technology and deep space exploration that require large investments, while companies need to start thinking about opportunities in the global space market, such as satellite services."

Managing Director, Starburst Korea

The Korean space industry is also taking its first steps towards entering the New Space era as technologies developed in the Old Space – property of the government until now – are increasingly being transferred to the private sector or at least enabling the private sector to capture value from those technologies. As it is essential for private companies to be able to develop successful space projects by themselves, the first initiative of the Korean government will be to transfer or enable access to rocket development technology to the private sector. This will mark a major shift for industry in Korea, as companies progress from manufacturing rocket parts to designing and manufacturing entire systems.

As an immediate step, ahead of the June 2022 launch of the next Nuri rocket, MSIT is planning to select a local company to operate the projectile as well as manufacture the launching vehicle for the next generational Korea Space Launch Vehicle (KSLV). The tender is expected to be published in the summer of 2022 and Hanwha Aerospace is considered the leading candidate for this project. The tender will be competitive and will require companies to prove their readiness to receive the technology. The selected company will receive technology that no other Korean companies have, putting it in a highly advantageous position as Korea enters the New Space era. The project will not only include the transfer of core technology and detailed drawings but also hands-on training from KARI. Other technologies owned by the government will include satellite platform and payload technologies developed by KARI.

Satellites

The market for satellites in Korea is expected to grow from GBP 1.85bn in 2020 to almost GBP 25bn by 2030. The demand is driven by various factors, including the need for secure and instantaneous communications that the current ground network is unable to provide. The applications of machine-to-machine communication based on satellite signals includes air mobility, traffic management and IoT. The key to realising it is through creating a constellation of small low-orbital satellites that weigh less than 500 kg.

"Korean industry is highly interested in cube satellites. UK has stronger capabilities compared to Korean companies in this field, which could be of area of cooperation."

CEO, Nara Space Technology

Since Korea developed its own satellite platform in the 1990s, the technology has matured for sizes ranging from cube to large satellites. However, Korea is still reliant on advanced sensors and payloads that are key to gathering intelligence while operating satellites. Significant investments will be made in coming years to bolster payload capabilities in the coming years, including launching low orbital satellites to provide space internet for commercial purposes while providing internet and communication services in remote areas.

Launchers

Korea has been launching relatively large satellites above 1 ton in weight and KARI has been focusing on developing larger and heavier launch vehicle to carry large satellites. However, a need has emerged for smaller launchers that are more cost effective to develop and launch, similar to the trend of increasing demand for small satellites. Alongside developing capabilities for the next generational KSLV, companies such as Hanwha Aerospace, Perigee Aerospace and InnoSpace are also investing in developing hybrid rockets that are safer and more cost-effective.

KEY PLAYERS

The Korean space industry is dominated by three major players, known as the Big 3: Korea Aerospace Industries (KAI), Hanwha Group and LIG Nex1. The three companies have unique capabilities. KAI, best known as Korea's only aircraft manufacturer, is the sole local system integrator (SI) while subsidiaries of Hanwha Group develop launchers and satellites. LIG Nex1, a major defence contractor, is the strongest player in the local space industry when it comes to satellite payloads.

"The space industry will explode from 2030 onwards. Until then, Korean companies will focus on government-led projects while building relationships with international companies to seek opportunities for future growth."

Team Leader, major Korean defense contractor

In addition to the Big 3, there are multiple smaller players supplying satellite services and equipment, such as Satrec Initiative, Hancom InSpace, Genohco, Kencoa Aerospace, and SOLETOP. This number is growing and diversifying as start-ups are joining the space industry. The first ever start-up in the field was cube-sat manufacturer, Nara Space Technology. Other notable start-ups in the industry include Perigee Aerospace, a manufacturer of methane-based liquid launchers, and hybrid propulsion specialist InnoSpace.

The industry sees space as an opportunity for future growth where they can leverage their existing capabilities. National flag carrier Korean Air is taking part in the MSIT's Space Pioneer project by developing common bulkhead propellant tanks for small satellite launch vehicles. Industrial equipment manufacturer Doosan Heavy Industries, as part of its reorganisation towards emerging technologies, is now manufacturing aerospace parts through 3D printing technology. Finally, Hyundai Motors Company is also looking to expand its business portfolio into space by investing in Urban Air Mobility technologies as well as developing an unmanned lunar rover.

Korea Aerospace Industries

Korea Aerospace Industries (KAI) is a major aerospace and defence manufacturer headquartered in the southern city of Sacheon. The company develops and manufactures various aircraft, including a fixed wing trainer jet, helicopters, UAVs. Its space business includes manufacturing satellites and launch vehicles. Established in 1999, KAI had 5,033 employees and generated GBP 1.61bn in revenue in 2021.

KAI is a leader in Korea's space manufacturing, accounting for 40% of the sector's manufacturing value, although KAI's GBP 87m space business is just over 5% of its overall revenue. KAI's major shareholders include the Export-Import Bank of Korea (26.4%) and the Korean National Pension Service (7.8%). In February 2021, KAI launched a New Space Task Force to target the private space industry.

KAI was responsible for integrating parts manufactured by 300 local companies for the Nuri rocket project. Within 2022, KAI plans to launch the next generation mid-sized satellite No. 2, which was designed, manufactured and integrated in-house. In 2021, KAI completed the construction of a new satellite manufacturing facility in Sacheon next to its headquarters that can produce and simultaneously assemble 6 large satellites, or 10 medium satellites or 20 small satellites.

Over the next five years, KAI plans to invest GBP 648.9m in an effort to expand its space business with the goal to launch a ground station and imagery analysis services for satellites. Through bolstering its satellite production capabilities, KAI sees export opportunities in Southeast Asia as demand grows for medium and large-sized surveillance satellites.

Hanwha Group

Hanwha Group is the leading conglomerate in Korea's space industry, with decades of experience in developing solid-propellant missiles as well as investing aggressively in satellite and antenna capabilities and third-party manufacturers. In March 2021, Hanwha announced a group-level business unit called the Space Hub with the purpose of coordinating R&D and investment across fields such as launch vehicles, satellite-based communications and Earth observation technologies.

Hanwha Corporation

Established in 1952, Hanwha Corporation is the holding company for Hanwha Group. The

Table 2: Hanwha's Space Hub

Hanwha Corporation	Hanwha Aerospace	Hanwha Systems	Satrec Initiative
Solid-fuel Rockets & Satellite Thrusters	Liquid-fuel Engines & components for liquid-fuel rockets	Communications satellites and services	Earth Observation (EO) satellites and payloads

Source: Intralink research

company specialises in explosives for both civilian and defence purposes and developing smart factory solutions. As of 2020, it has 4,762 employees and revenue of GBP 33.2bn. Hanwha Corporation has experience in developing both solid-fuel propulsion and liquid-fuel systems, including for the Naro rocket project, where it has been involved in developing and manufacturing the upper propulsion unit, including a kick motor and a thrust vector control system. The company plans to jointly develop with KARI "Storable Bipropellant Thruster" technology by 2025 which will be a first for Korea.

Hanwha Aerospace

Hanwha Aerospace is a manufacturer of aircraft engines, parts manufacturing for military aircraft and space launch vehicles established in 1977. The company had almost 2,000 employees and revenue of GBP 4bn in 2021, up 20.6% from the previous year. Hanwha Aerospace was contracted by KARI in 2016 to produce a liquid rocket engine. Hanwha Aerospace has developed 6 liquid engines for KSLV-2 along with turbo pumps, valves and thrust vector control systems. The company also has plans to develop and manufacture a small satellite launcher in cooperation with KARI.

Hanwha Systems

Established in 2000, Hanwha Systems had 3,820 employees with GBP 1.28bn in revenue as of 2021, a 27.2% increase from 2020. The company has broad business areas including ISR sensors, cyber security solutions and Urban Air Mobility. The company plans to build a constellation of 2,000 small satellites, less than 100 kg in weight, in LEO by 2030 for providing connectivity to urban cargo-delivery drones and passenger airplanes. In the medium-term, Hanwha Systems is also responsible for building high-resolution surveillance satellites for both civilian and military applications that will enable real-time monitoring of North Korea and neighbouring countries.

Satrec Initiative (Satrec-I)

Established in 1999, Satrec Initiative is a manufacturer of small and medium-sized satellites which are chiefly used for Earth observation. Founders of Satrec-I developed Korea's first satellite, KITSAT-1 that was launched in 1992, as researchers at the "Satrec" centre at KAIST. In January 2021, Hanwha Aerospace acquired a 30% stake in the company, becoming its largest shareholder. Satrec-I has 298 employees and reported GBP 54.9m in revenues in 2020. The company's future plans include development, production and launching of SpaceEye-T by 2024, an earth-mapping satellite weighing 700kg, designed to provide high resolution images at 30 centimetres per pixel.

LIG Nex1

Established in 1998, LIG Nex1 specialises in developing and manufacturing precision guided munitions, C4ISR systems and avionics. The company reported GBP 1.1bn in revenue as of 2021 and had approximately 3,200 employees. While focusing on defence satellite projects, LIG is also contracted by DAPA to launch GEO-Kimpsat-3 (Geostationary Earth Orbit Korea Multipurpose Satellite 3) in 2027 to allow multi-band communication aimed at providing broadband satellite communication services. LIG is expected to be a satellite payload supplier for the KPS project.

Table 3: Big 3 manufacturers' international partnerships

Local Company	International Company	Area of Interest	Project
KAI	Space X	Launcher	Next-generation mid-sized (500kg) satellite No. 4
KAI	AirBus	Satellite	Small low-earth-orbit (LEO) satellites
Hanwha Group	OneWeb	Space internet	2,000 satellite constellation in LEO
LIG Nex1	Thales Alenia	Digital processor	GEO-KOMPSAT-3 expected to launch in 2027

Source: Intralink research

SUB-SECTORS

Satellite services, the utilisation and processing of satellite signals, are the single largest portion of the Korean space industry and comprise more than half of the industry. The broader satellite service segment was estimated to be worth GBP 1.31bn in 2020, approximately 60% of the industry total, while manufacturing was worth GBP 618m and accounted for just under 40% of the industry. Korea still does not have a significant presence in space operations such as launching services or satellite operations, due to both the lack of infrastructure and demand. For these reasons, financial and legal services related to space are also in their infancy.

Manufacturing

As of 2020, there were 233 companies in total within the space manufacturing industry, of which the largest number (87) focused on ground systems manufacturing, followed by launchers (84) and satellite platforms (62). The majority of the companies focus on manufacturing hardware components for satellite platforms and launchers but payload manufacturing is comparatively weak. Korea still relies on importing satellite antennas from European and American producers. In addition, the industry imports other sensors such as control moment gyroscopes (CMG) and onboard computers. Korea is believed to have reached 65% localisation capability in satellite manufacturing, although the government and industry continue to invest with a view to localising the remaining 35%.

Satellite services

Satellite services include remote sensing, satellite broadcasting and communication and satellite navigation. Out of 165 companies, 34 organisations are engaged in the remote sensing area that utilises satellite signals to observe diverse activities and phenomenon on Earth such as the climate. The two strongest areas for Korea are broadcasting and communications which has 67 companies that provide high-speed connectivity and communication services, and satellite navigation which also has 67 players. Most of the revenue generated within Korea's commercial space industry is generated from the satellite services sector as it focuses on providing communication and navigation services to users.

Space operations

Space operations consist of providing services such as satellite leasing, deep space research and space exploration, as well as financial, legal and consulting services. This sector is in its infancy in Korea as most projects are government-led. However, it is expected to grow along with the growth of the private sector space industry. There are a few companies, such as Unmanned Exploration Laboratory, KB Insurance and Samsung Insurance, which are dedicated to conducting scientific research and deep space exploration, as well as a number of insurance providers.

Start-ups

The Korean start-up scene is new to space but has been growing in numbers over recent years. The best-known success is Nara Space Technologies, established in 2013 with the mission to develop cube satellites, in which there is growing interest from both government and VC firms. Perigee Aerospace, a developer of a small launcher, received over GBP 6.1m in funding in 2019 from among others, Samsung Venture Investments and LB Investment. Another start-up focusing on developing a small launcher with a hybrid engine, InnoSpace, received GBP 4.9m from Company K Partners, FuturePlay and Kolon Investment.

Defence

Defence space projects are led by ADD and subcontracted to private companies. Although the majority of the projects are subcontracted to the Big 3 in KAI, Hanwha and LIG, there are a number of smaller players active in manufacturing parts for launchers and satellites. For example, Hanwha Systems is subcontracted by KAI for developing satellite platforms and works with Satrec-I while cooperating with Hancom InSpace for an ADD surveillance satellite project.

OPPORTUNITIES

There are a number of areas within the Korean space industry that represent areas of opportunity for UK companies, despite the ongoing push for localisation from the Korean government. These areas include satellite payload, mainly communications technology, as well as the development of smaller systems. Major upcoming projects are likely to focus on local companies as prime contractors, but there is likely to be room for overseas companies with innovative, in-demand technology.

"The UK is a leader in open innovation as well as in New Space. Korea has much to learn from the UK, such as the Harwell Space Cluster and UK start-ups in the space sector. If UK companies with innovative ideas collaborate with Korean manufacturing capabilities, both parties will greatly benefit from the collaboration."

CTO, KTsat

In-demand technologies

According to research from KISTEP, Korea is 18 years behind the US in launcher technology and 15 years behind in satellite technology. Korea has a number of companies with capabilities in developing satellites and ground stations, but there is room for improvement in launchers, payload, and satellite applications as the technology has not kept pace. The inability of the Nuri rocket to reach satellite deployment altitude despite a successful launch underscored the need in this area.

Korea lacks payload capabilities such as synthetic-aperture radar (SAR) technology, which is integral to satellite surveillance systems. Numerous cube satellites were launched in recent years, but companies struggle to communicate with the units, pointing to the need to make improvements in the industry's communications technology. In addition, Korean companies also lack satellite image processing technology as the sole domestic demand to date has come from the government. Korean companies may eventually succeed in developing these technologies internally, but for now there is a need to source these externally. In addition, Korean companies are looking to secure inter-satellite communication technology to augment its communication capabilities.

> **"It makes sense for the Korean government to localise the basic technology for space. However, when it comes to deployment or mass production, we need to work with the best technology we can get."**
>
> **Business Innovation Team Leader, Hancom InSpace**

The space industry offers non-satellite opportunities as well. As Korea signs Artemis Accords with NASA with the aim to reach the moon by 2030, KARI will be launching Korea Pathfinder Lunar Orbiter in August 2022. By 2030, Korea aims to launch a domestically developed moon lander with an indigenous rocket. In addition, Korean Air, the national flag carrier, is conducting a feasibility study on air launching technology. This involves using a mother ship to launch rockets, missiles and parasite aircraft at an altitude of 12 km. Until recently, Korea was prohibited from developing air launch capabilities due to the 1979 Revised Missile Guidelines, but their lifting in May 2021 opened a new avenue of research and development in Korea.

Major projects

Korea sees space as a highly strategic future growth engine and there are several major upcoming projects that underline the importance that the government attaches to the sector. Since there is much emphasis on localising core technology as well as gaining operational independence for intelligence gathering, major projects are heavily focused on improving satellite capabilities. The MSIT has set out a roadmap for launching approximately 100 small satellites by 2031, half of which will be for surveillance purposes. Approximately 40 of these small satellites will be equipped with SAR technology and managed by the MND and 11 will be managed by the MSIT, installed with EO sensors.

The KPS is the largest space project in terms of budget in addition to having the longest timeline. The government has allocated GBP 2.2bn as a budget across more than a dozen years from 2022 to 2035. The project is tipped to be awarded to LIG Nex1, which was responsible for conducting a decade-long preliminary study in this field. On-going defence projects include mini-SAR satellites developed by the ADD with a timeline for completion by November 2023. Vendors for this project include Hanwha Systems which is responsible for developing a small SAR and Satrec-I who will be tasked with designing and manufacturing the satellite.

There are two other major opportunities in the civil space sector: the MSIT's Space Pioneer Project and the planned lunar mission in 2030. As a part of the trend in the Korean space industry as well as through Space Pioneer Project, the government is looking to

> **"As lots of satellite projects are being run by the Ministry of National Defense, room for international cooperation is narrowing. However, even with projects that are limited to local companies, there is still room for international companies, especially if they can help ensure the project succeeds."**
>
> **Chief Manager, Satellite Business, LIG Nex1**

support local industry to localise state-of-the-art parts for launchers and satellites. Despite the fact that Korea has largely achieved independence in designing and integrating the final product of, on average of 65% of space systems were locally sourced and industry is still reliant on imported parts for many core technologies. Another ambitious project is the lunar mission that consists of two parts: launching the moon orbiter in summer 2022 to conduct scientific research and launching an unmanned moon lander, possibly a rover, by 2030 with locally developed spacecraft and KSLV-II rocket. Private vendors for the lunar lander project have yet to be determined.

CHALLENGES

Market access

For UK companies, the Korean government's drive to localise core technologies to gain independence in space technology poses a potential hurdle to market access. Localisation undergirds major space projects such as the Nuri rocket program and the KPS, as well as the military's solid fuel rocket programme, where the success of the project is measured in large part by its activation of local design capabilities, technology, components and manufacturing.

There is still room for international cooperation, especially if a UK's company has capabilities that are far beyond what their Korean counterparts can achieve and this is shown in NASA's broader cooperation with KARI on the Nuri project and the role of SpaceX in the June 2022 Nuri launch. However, upcoming government projects will continue in their efforts to reduce the non-domestic provision of products and services. The Korean space industry remains dominated by the government, although the emergence of a vibrant private sector space industry may offer more opportunities for UK companies in the longer term.

Another hurdle for international players is the complexity of the government procurement process for both civil and defence applications. Even where UK companies are able to participate in a government tender, the bidding process is highly complicated and requires significant amounts of documentation from international companies, potentially all translated into Korean. Once selected as a

vendor, the contract negotiation phase, separate from technical negotiations, can be similarly complex for companies not used to Korean government requirements and procedures. A local partner can help offer transparency and knowledge on the procurement process.

Korea may also differ in industry and regulatory standards from other countries. These differences may serve to protect local companies from foreign competition both intentionally and unintentionally. For example, in the satellite payload sector, regulations keep companies from advancing their technology. If the satellite imagery goes below 5m resolution, the company that developed the sensor may be held legally liable - for national security purposes. The rigidity of the Korean government is posing as a hurdle for technological advancement in the local industry and for foreign companies with technology capable of achieving that resolution, the regulation is hampering market entry.

Competition

The Korean market is highly competitive as the Korean government is currently the only purchaser of space technologies and services. Although the local industry is growing, UK companies looking to the Korean market may face fierce competition from the growing number of domestic players, as well as European and American companies already in the market. Domestic players such as Hanwha, KAI and LIG Nex1 are not only increasingly capable in terms of their technological capabilities but benefit from a strong government mandate for localisation.

Where opportunities for international companies exist, a preference for these American and European solutions, often rooted in deep partnerships in the aerospace and defence sectors, may be hard to displace. For example, Thales Alenia Space, a French-Italian aerospace manufacturer has a strong partnership with Hanwha Systems. Similarly, German Airbus Defence and Space has a partnership with LIG Nex1. Major American players such as Boeing, Lockheed Martin and Northrop Grumman naturally also have a large local presence due to the strong security partnership between Korea and the United States. UK companies with highly specialised technologies will find opportunities in the market, but they are encouraged to have a local presence to forge partnerships with both local industry and government and a long-term view of developing the market.

PROCUREMENT ROUTES

Broadly, UK companies looking to enter the Korean space market can either enter the market by themselves, whether that be through a local sales representative or by setting up a local branch office, or they can partner with a local company. The former will enable the company to retain more independence but will involve having to navigate a complex public procurement system while the latter approach entails giving up more autonomy and brings partner selection risks but should offer the advantage of more local knowledge, established local contacts and local resource to manage the complex process of participating in local tenders. Some contracts may only be available for companies with a locally registered entity.

General public sector (PPS, KARI)

The Public Procurement Service (PPS) is the central public procurement agency that manages the purchase of commercial goods, equipment and services on behalf of Korean government agencies. To register for a tender, a foreign bidder must provide proof business registration from either its country of origin or from Korea. All documents must be issued by the relevant public authority of the applicant's country or be notarised to be deemed valid.

There are several types of bidding and contracting processes. Government agencies as customers can set forth different competition schemes, such as allowing all qualified suppliers to make their bids or allowing only those they nominate to bid or even by directly negotiating with the candidate that meets the criteria of company selection.

Tenders can be either limited to local or international suppliers or open to both. Some bids may require a two-track process with separate commercial and technical submissions. In such cases the customer will first select their preferred technology then select a supplier in consideration of the price. Bid bonds worth 5% of the total bid price may be required but can be waived with the submission of a memorandum of bid bond payment. Since the PPS publishes government-funded projects, tenders will be published in Korean without any translation.

- PPS procurement portal: www.g2b.go.kr

Defence (DAPA and ADD)

The Korean government governmental body responsible for defence procurement is the Defense Acquisition Program Administration (DAPA). DAPA regularly updates its foreign purchase and bid information service website, which can be found here.

Under DAPA's general procurement system, there are three major procurement methods: 1) domestic development projects 2) Direct Commercial Sales (DCS, international procurement) 3) Foreign Military Sales (FMS, government to government). The procurement method is determined by the Ministry of National Defense.

For UK companies, there are two ways to participate in defence projects. One is through participating in domestic development projects as technical consultants for local defence contractors, while the other is as a prime contractor through an international procurement procedure. Given the government's intention to localise core

technologies, an increasing number of bids are being allocated as local development projects, leaving little room for international firms to apply directly.

ADD publishes its public bid announcement in three different locations: ADD page, G2B and Alio where companies can access RFP documents and bid requirements. Unfortunately, procurement websites are in Korean and does not provide English options to allow non-Korean speakers to easily navigate. In most cases, ADD requires companies to submit the proposal and bid application documents in hard copies hand delivered in person due to confidentiality reasons. Should the supplier do not comply with submitting the required documents listed in the RFP for bid application, the company is automatically disqualified from submitting the proposal.

- DAPA Procurement procedure: www.d2b.go.kr
- DAPA Foreign procurement: www.d2b.go.kr
- ADD Foreign procurement: www.add.re.kr

Commercial B2B approach

In certain cases, UK companies may be able to sell directly to a Korean company, which may be an end user or systems integrator. Large companies, which could be either an end user or an integrator, typically have dedicated teams for examining new business opportunities as well as engaging with overseas business partners. The sales process can be lengthy and complicated requiring extensive technical discussion and may even require sharing significant amount of sensitive information.

Language and cultural barriers may also impede effective discussions. Working with an in-country partner, which can either facilitate the sale to an end user or integrator, can help mitigate some of these issues, although it may cause other issues itself. A local partner can also identify upcoming projects and opportunities, as well as reduce delays caused by time zone differences.

Another method of understanding the market and seeking out opportunities for UK firms is by participating in trade shows and industry forums, which can offer the chance to meet with potential customers and partners. As Korea becomes an increasingly active player in the aerospace industry, a growing number of companies engaged in the space business are attending events both domestically and internationally.

RELEVANT EVENTS & ASSOCIATIONS

Table 4: Upcoming events

Events	Website	Area	Dates
ADEX 2023	www.seouladex.com	Aerospace and defence	October 17-22, 2023
DX 2022	www.dxkorea.org	Defence, land systems	September 21-25, 2022
Defense Industry Fair	www.hi-defense.or.kr	Defence manufacturing and parts, SME focus	June 15-17, 2022

Source: Intralink research

Table 5: Relevant associations

Associations	Website	Description
Korea Association for Space Technology Promotion	www.kasp.or.kr	Holds conferences and exhibitions to promote space industry
Korea Aerospace Industries Association	aerospace.or.kr	Facilitates industrial cooperation under MOTIE
The Society for Aerospace System Engineering	sase.or.kr	Promotes R&D-based industry cooperation

Source: Intralink research

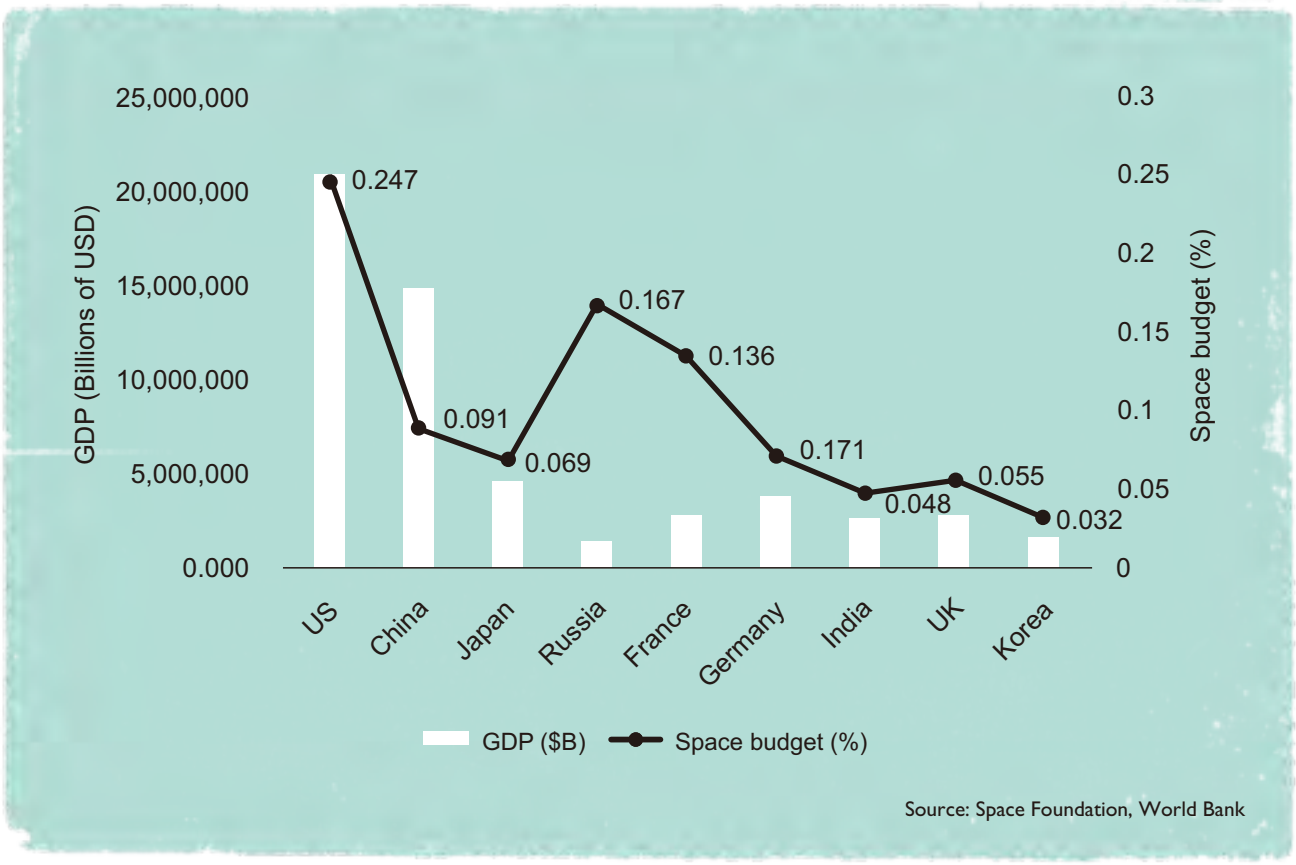
05

R&D AND ACADEMIC OPPORTUNITIES

OVERVIEW

Korea is consistently one of the largest spenders on R&D as a percentage of GDP, spending 4.81% in 2020, ranking second only to Israel, compared with 3.1% for the US, 2.4% for China and 1.8% for the UK. Korea also ranked fifth in absolute amounts, spending GBP 57bn as compared to GBP 38bn for the UK. Close to three-quarters of national R&D spending comes from the private sector, where leading conglomerates such as Samsung, LG and Hyundai invest in new technologies including, increasingly, in basic research.

Figure 5: Global space budgets as a percentage of GDP



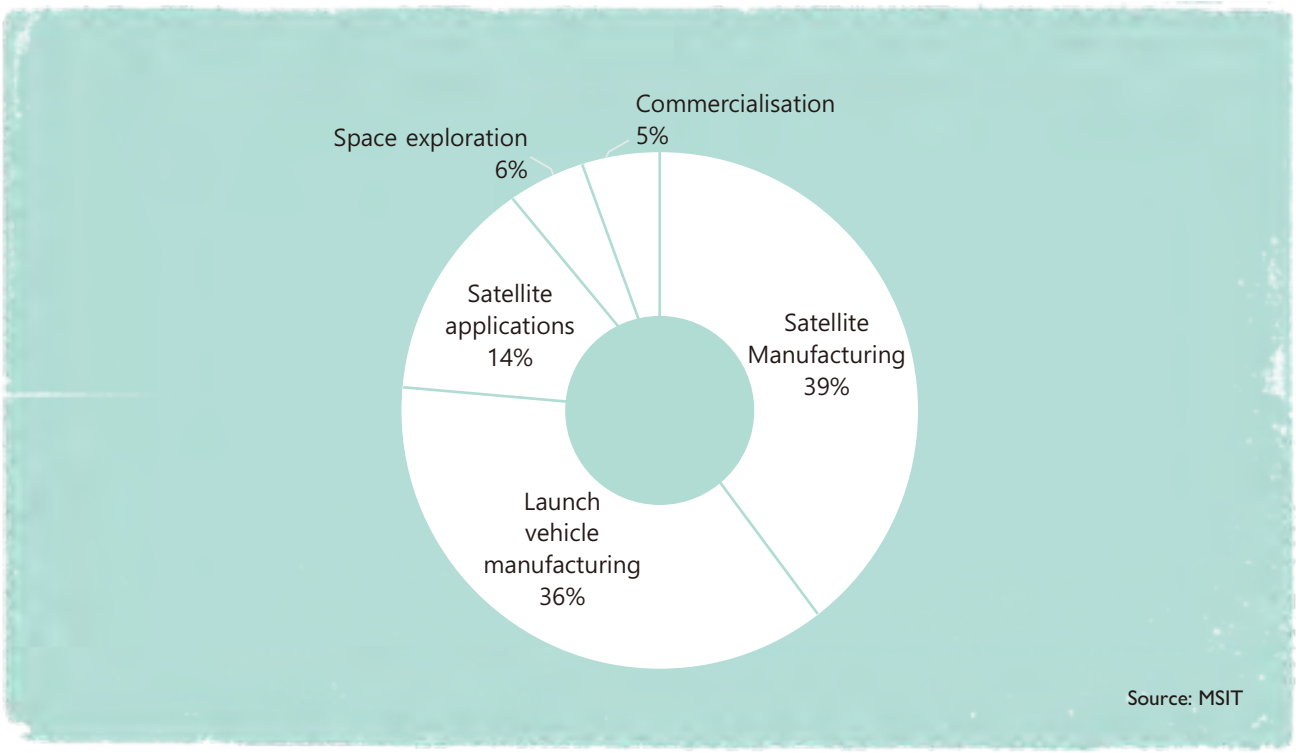
Source: Space Foundation, World Bank

R&D funding tends to be concentrated in large, government-backed projects tied to strategic industries such as semiconductors, AI and robotics. The local aerospace industry is considered strategic and has made significant strides in capabilities thanks to government backing, but the overall space R&D budget is still very small.

Korea's space budget for 2022 is GBP 455m, up almost 20% from GBP 380m in 2021, but significantly smaller than countries such as Japan (GBP 1.9bn), the United States (GBP 14.4bn) and China (GBP 8.1bn). The gap remains large even when adjusting for spending as a percentage of GDP, where Korea ranks 10th at 0.032% of GDP, ahead of the UK (0.030%) but behind the United States (0.25%), Russia (0.21%) and China (0.122%). Countries like Saudi Arabia, Italy and Germany also stand out for having significantly higher spending than Korea.

R&D funding mostly focuses on satellite manufacturing (39%) and launch vehicles manufacturing (36%) at roughly equal proportions. Satellite applications (14%), space exploration (6%) and commercialising technology (5%) make up the rest. KARI dominates government-led R&D work, accounting for almost 80% of the budget, with smaller research institutes such as the Korea Astronomy and Space Science Institute (KASI) representing the balance.

Figure 6: Breakdown of Korean space R&D budget



KEY STAKEHOLDERS

There is a diverse ecosystem of stakeholders involved in space R&D within Korea. They include ministries such as the MSIT and the MND, public research institutes, universities, academic associations and agencies such as the National Research Foundation which provides funding for research.

There were a total of 25 research institutes participating in space R&D as of 2020, including KARI, ADD, KASI and the Electronics and Telecommunications Research Institute (ETRI). Two of Korea's leading universities, Seoul National University (SNU) and the Korea Advanced Institute for Science and Technology (KAIST), are also active in space-related research. The Korea Society for Aeronautical & Space Sciences (KSAS) is another stakeholder, particularly within academic research.

The National Research Foundation (NRF), established in 2009 to better coordinate R&D at a national scale, is responsible for funding smaller, less commercially oriented projects. It has a budget of GBP 4.5bn and includes support for four types of national strategic R&D, one of which is space. The strategic space funding covers core technology, launch vehicles and lunar exploration. The NRF earmarks a portion of its budget specifically for international research collaboration.

The MSIT similarly has a Space Technology Division that oversees launch vehicle development, New Space policies and space industry funding. KARI has separate divisions for R&D on launch vehicles, satellites, and future technologies. Similarly, the ADD has a division developing space defence technologies along with five others working on areas such as AI, cybersecurity, energy and radars.

Table 6: Local stakeholders in space R&D

Government	Universities	Research Institutes	Academia & Funding
Ministry of Science and ICT	KAIST Korea Advanced Institute of Science and Technology	국방과학연구소 Agency for Defense Development	한국항공우주학회 The Korean Society for Aeronautical and Space Sciences
Defense Acquisition Program Administration	서울대학교 SEOUL NATIONAL UNIVERSITY	KASI Korea Astronomy and Space Science Institute	NRF National Research Foundation of Korea
Ministry of National Defense Republic of Korea	충남대학교 CHUNGNAM NATIONAL UNIVERSITY	KARI 한국항공우주연구원 Korea Aerospace Research Institute	

Source: Intralink research

The Department of Aerospace Engineering at SNU has 15 professors working on a range of areas, including aerodynamics, combustion, guided navigation control and material application. SNU graduates are prominently in the Korean aerospace industry, represented in government, research institutes and private industry. KAIST, a national research university located in the central city of Daejeon, conducts research on flight and space exploration including UAV, drone, satellites, air traffic management and satellite navigation system.

TRENDS

Overall, government R&D is in the middle of a transition from a top-down approach focusing on large, strategic projects to include smaller projects driven by individual researchers. This shift was achieved by increasing the amount of funding made available by the NRF, which is now roughly equal to the amount of funding from large government projects at GBP 4.4bn. The NRF now also offers greater support for basic scientific research, which has doubled between 2017 and 2022 to reach GBP 1.6bn.

A similar trend is underway at the ADD, which is also seeking to become more collaborative and shifting towards the development of technologies without necessarily thinking about their applications into weapons systems. The change in defence sector R&D was confirmed by passage of the National Defense Science and Technology Innovation Promotion Act in 2020 in the hopes of making defence R&D as innovative as private R&D. The law has the purpose of transforming weapon-oriented defence R&D into more open and collaborative civil-military R&D on defence science and technology.

Nevertheless, even as overall national R&D strategy changes to become more flexible and promote innovation, spending on space as a proportion of overall R&D has not kept up. In fact, spending on space R&D as a proportion of overall R&D went down every year from 2016 to 2020 based on MSIT figures. Although the overall space budget, most of which is focused on R&D, increased by almost 20% in 2022, the rise was followed by several years of decreases or small increases. In fact, the increased figure of GBP 455m for 2022 is still lower than the GBP 463m budget in 2016.

"Large R&D funding still comes from the government and most of it is allocated to KARI, KASI and ADD, who conduct the majority of large-scale R&D. The private sector is still obstructed from leading these big projects."

Professor, Department of Aerospace Engineering, Korea Advanced Institute of Science and Technology (KAIST)

Projects such as the KPS with broader, industrial applications outside of space exploration have received significant amounts of funding, pointing to the continued centrality of commercial viability in national R&D. Also, Korea has aggressively expanded the space R&D in a large scale, with interests in international cooperation in the following: construction of international space station, establishment of GNSS, space applications in disaster management via satellite videos, and development of dual-use flight vehicles. Space budgets, meanwhile, are concentrated on the achievement of national strategic goals such as the Nuri rocket programme and lunar exploration, with relatively little attention paid to basic space science. It appears that the government may be hoping for private companies to take the lead in expanding the scope of its space R&D.

Personnel development has been identified as a weakness and is accordingly receiving government support in order to grow the pool of researchers for academia and industry. In January 2022, the MSIT announced Future Space Education Centers at five universities, supported by GBP 3.1m in funding over five years, with the goal of producing more than 250 space researchers at the graduate level. The program is forward-thinking in seeking to identify areas of high demand in the future. The areas of focus are logistics, mining and communications in space.

R&D CAPABILITY ANALYSIS

Korea's space R&D capabilities have been continuously improving in recent years. KARI and its private sector partners have demonstrated an ability to develop increasingly sophisticated launch vehicles and satellites capable of meeting the goals and requirements of the national space programme. The increase in capability has also largely come about through the participation of local players, without reliance on international organisations or companies to supply technology or resources.

There are exceptions, though, such as the help of the US with Korea's lunar exploration programme. The planned 2022 launch of a Lunar Orbiter will not use the Nuri rocket, but a SpaceX rocket. NASA has also provided assistance throughout the development of the lunar orbiter, particularly for deep space communication and navigation technologies. Korea plans to continue from lunar orbit in 2022 to a lunar landing in 2030, it is unclear whether it will be able to do so solely through locally developed technology and expertise.

In the absence of a large space budget, Korea may require outside help in the form of technical expertise. Korea has a comparatively narrow area of strength, the result of ambitious goals and a comparatively small budget. Korea has made major strides in technical capabilities related to space, but in many cases has decided to rely on technology transfers through cooperation with international partners. As its ambitions increase, the space budget will either need to increase significantly or, as is more likely based on conversations with industry insiders, Korea will rely on technology transfers and

acquisitions in order to achieve goals of indigenous production.

Another area of weakness for local R&D is the narrow scope of the programme, which has to date focused on meeting high profile goals. The state of academic research in space, particularly on topics outside core areas of expertise, is not as strong as overall technological capacity. Centres of excellence for space research are limited to KARI and to a lesser extent, SNU and KAIST. In particular, Korea lacks researchers who can analyse satellite-filmed information. KARI concentrates on developing satellites, and universities professors predominantly have expertise in satellite development technology.

"Universities should nurture space experts and researchers. However, we lack the funding, curriculum and even the faculties. The fact that space only recently started to attract attention in Korea means space R&D was always about missiles and defence, while basic science research has not been a focus."

Professor, Department of Mechanical & Aerospace Engineering, Seoul National University

INTERNATIONAL ENGAGEMENT

The Korean space programme has a long history of international R&D cooperation with a lot of countries, including the US, EU, Russia, China and Japan. For years, Korea's international engagement in space saw it as a recipient in terms of core technology for rockets and satellites, launch vehicles and launch sites. However, Korea is increasingly sharing its expertise with other countries, most notably the UAE, but also countries in Africa and Southeast Asia.

US

The United States looked at the Korean space programme cautiously for a long time due to concerns about nuclear proliferation, despite the close security relationship between the two countries. However, Korea has had a history of cooperation with NASA that was formalised in 2008. Cooperation between KARI and NASA intensified in 2016 with the signing of an agreement to support Korea's lunar exploration programme. Specifically, NASA has been supporting KARI on payload, communication and navigation technology for the Lunar Orbiter launch scheduled for 2022.

EU

Korea has had a long history of cooperation with the EU, dating back to the role of Arianespace in the launch of Korea's first satellite. Korea signed an agreement with the EU in 2006 to support the development of Galileo, the European satellite navigation system. KARI has signed with a number of counterparts within the EU, including the Netherlands Space Office and the French CNES (Centre National D'Études Spatiales).

Areas of cooperation include joint R&D on satellite information applications, microsatellites and space exploration, as well as the exchange of personnel.

UK

Although space cooperation between the two countries has been limited in recent years, space cooperation between Korea and the UK, along with broader cooperation on science and technology, has a long history. The two countries signed a Science and Technology Cooperation Agreement in 1985, reviewed and updated every two years, and Surrey Satellite Technology played a key role in designing Korea's first satellite, the KITSAT-1, in 1989.

"KAIST's Satellite Technology Research Lab (SaTRec) sent graduates to the University of Surrey for their master's studies, which led to successful development of KITSAT-1 in 1992. It opened a new chapter in space cooperation between the UK and Korea."

Professor, Department of Aerospace Engineering, Chungnam National University

Russia

Korea signed an agreement for cooperation in space with Russia in 2004 to support development of the Naro Space Center, as well as the first stage of the Naro-1 rocket. The 2004 agreement was followed in 2006 by a Technology Safeguard Agreement in response to US concerns to ensure that Russian rocket technology was not transferred to Korea. Russia also supplied the first stage of the Naro-1 rocket in 2013.

Japan

Bilateral relations between Korea and Japan have been strained in recent years, but KARI did sign a bilateral agreement in 2006 with JAXA, the Japanese space agency. In 2012, Korea's KOMPSAT-3 was launched from Japan's Tanegashima Space Center by a Japanese rocket manufactured by Mitsubishi Heavy Industries.

China

Bilateral and multilateral cooperation on space development between Korea and China has been limited in recent years due to cooling ties between the two nations, the growing autonomy of the Korean space programme and continued close cooperation between the Korea and American space programmes, which presents regulatory barriers. However, as recently as 2001, Korea considered the use of a Chinese rocket to launch a satellite.

UAE

Korea played a major role in helping to develop the UAE's capabilities by training

scientists and providing technology for its first two satellite launches in 2009 and 2013. The capacity shared by Korea paved the way for the UAE's first domestically produced satellite in 2018.

Australia

In December 2021, the Korean MSIT signed an MOU on space cooperation with the Australian Department of Industry, Science, Energy and Resources. The areas of cooperation covered by the MOU include space exploration, satellite navigation and launch capabilities.

ACADEMIC CONFERENCES & EVENTS

Table 7: List of academic conferences and events in 2022

Event	Host	Website	Dates
Spring Symposium	The Korean Society for Aeronautical & Space Science	ksas.or.kr	April 20-22
Spring Symposium	Society for Aerospace System Engineering	sase.or.kr	May 18-21
Spring Symposium	Korean Society of Propulsion Engineers	journal.kspe.org	May 25-27
Seokyung Space Forum	Seoul Economic Daily and KSAS	ksas.or.kr	June
General Assembly	Inter-Agency Space Debris Coordination Committee (IADC)	www.iadc-home.org	June
IAU General Assembly	Korean Astronomical Society	en.kas.org	August 1-12
UN Space and Women Workshop	UN Office for Outer Space Affairs	www.unoosa.org	August
Fall Symposium	The Korean Society for Aeronautical & Space Science	ksas.or.kr	Third week of November

Source: Intralink research

OPPORTUNITIES

Korea represents opportunities for international R&D collaboration given the ambitions of its space programme over the next 10 years and its comparatively small space budget. Despite publicly stated goals of localisation and self-sufficiency, it is unclear whether Korea will be able to achieve its goals, such as a lunar landing, without outside support. This may not necessarily present commercial opportunities, but R&D collaboration that builds capacity within domestic organisations in Korea is more likely to succeed. Such collaboration is best pursued at an institutional level, preferably between government agencies.

Opportunities for R&D collaboration are likely to be tied to the competitiveness of technology in strategic sectors. For the UK, specifically, highly potential sectors for joint R&D would be satellite technology, which dovetails with two major projects both in defence and industry. Intergovernmental partnerships between KARI, the new national space agency or other research institutes in Korea and UK counterparts such as the UK Space Agency are likely to yield the best chances for large-scale cooperation. Possibilities for partnership include joint R&D agreements or MOUs for information-sharing and personnel exchanges.

"If the UK Space Agency would like to further cooperate with Korea, KSAS is a good platform to get acquainted with local academic and policy players. KSAS could be a communication channel with the new Korean space agency expected to be established this year."

Former President, KARI

Opportunities for collaboration at the university level are another channel to explore. There are 119 university aerospace engineering departments in Korea and researchers have expressed interest in joint R&D with the UK on launch vehicles, satellite radars and thermal infrared sensors. Emerging services and technologies also represent areas for R&D cooperation: satellite internet, space planes, solar panel development, LEO (low-Earth orbit) satellite services commercialisation, space mining, and tourism.

Funding from the NRF is available for international research cooperation and may in fact be bigger for universities working with international partners. Given the fact that domestic-only R&D projects of universities are poorly funded by the NRF that tends to prefer big research conducted by institutes, universities may be able to acquire more funds for cooperation on satellite services if working with UK researchers or universities.

Challenges to space R&D collaboration between the UK and Korea include a preference for organisations and institutions in the US, small R&D budgets and relatively small interest in basic space science. Korea has a relatively small number of research institutes specialising in space R&D and most of the funding for space R&D is tied to large government-led projects focusing on satellites and launch vehicles.

Korean organisations and academic institutions tend to look first towards collaboration with the US due to the strong governmental and institutional ties between the two countries. Major national space projects have often been modelled on similar projects in the United States, influenced strongly by exchanges with NASA. Many Korean researchers have also studied in the US and have existing networks in the US in the form of previous advisors or colleagues.

Similarly, the comparatively larger profile of the US and EU within space R&D may give US and EU organisations an advantage over the UK for institutional cooperation. As such, in the case of intergovernmental cooperation, the UK's strengths in space would need to be represented by an institution such as the UK Space Agency or the Department of Business, Energy & Industrial Strategy (BEIS).

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