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RISING STARS

Beyond the hype, unveiling opportunities in NewSpace

CONTENT

The past 10-15 years have marked an undeniable paradigm shift in the space industry known as NewSpace. Private capital is surging, innovation cycles are shrinking, and commercial applications are multiplying. This revolution has given rise to numerous flourishing ventures, from launchers and in-orbit services upstream to space situational awareness and Earth observation platforms downstream, all fueled by abundant capital. The disruption is real, and the business potential is substantial.

In this white paper, we will guide investors through the NewSpace landscape, unveil the prevailing trends, and assess the genuine opportunities that lie beyond the hype. Indeed, expectations have now returned to more realistic levels after two years of overpromises and SPAC-related inflation, which should provide more solid grounds for investing. Furthermore, the slowdown in investment in the sector since early 2022 has been limited compared to other tech businesses. Governmental backing is still proving to be a key support for the industry, with growing concerns about sovereignty boosting public investment and orders. Meanwhile, the potential ahead in both commercial and defense applications remains intact.

Nevertheless, as capital becomes scarcer, selectivity will increase. Beyond technological considerations, maturity and proven business cases will be key criteria. We may also witness a surge in M&A in the sector more quickly than anticipated, particularly in the most capital-intensive, fragmented, and early-stage commercial activities.

THE NEW FRONTIERS OF **SPACE TECH**

SECTION 1

After the awe-inspiring Moon landings, one might argue that progress in the space sector seemed to have reached a plateau. However, the advent of the NewSpace movement, gaining momentum around 2010, has revolutionized the industry with drastically distinct approaches inspired by Silicon Valley's methods. Spearheaded by SpaceX, the introduction of reusable rockets and small satellites has effectively reduced costs, unlocking a realm of fresh possibilities and ushering in a new era of innovative space technologies.

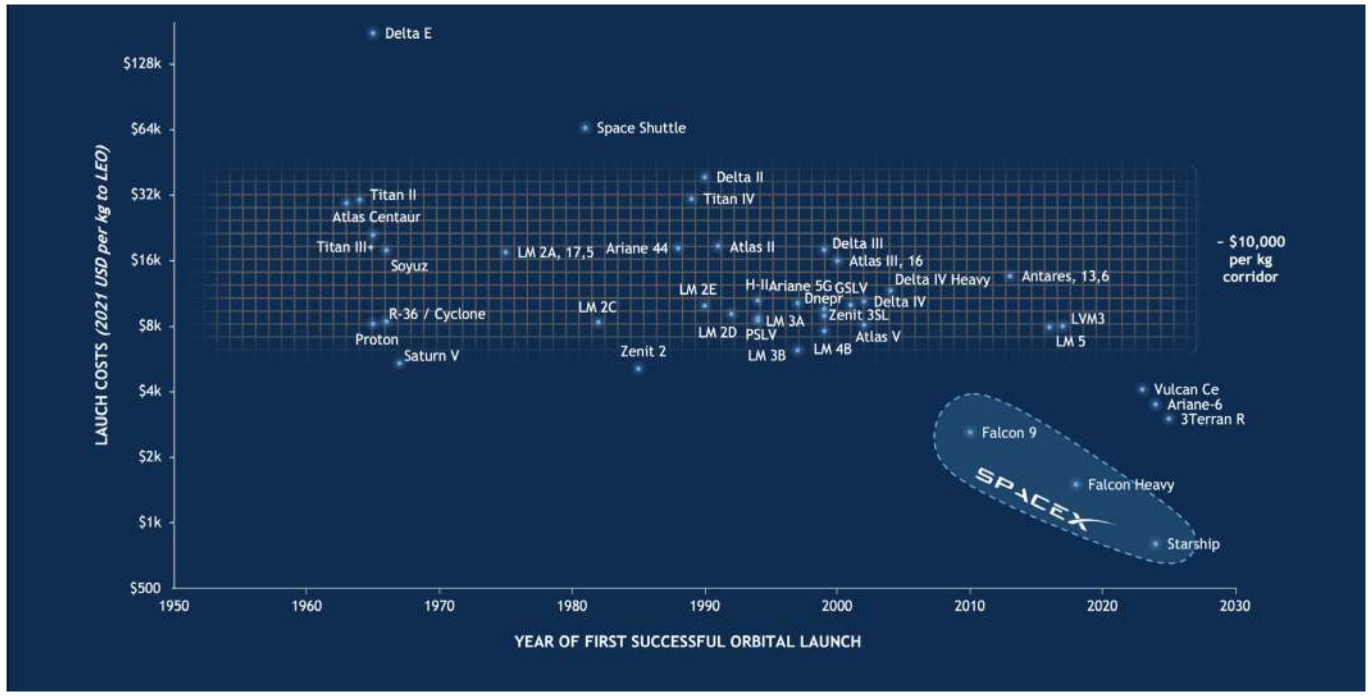
1.1 THE **DEVELOPMENT** OF REUSABLE, LOW-COST ROCKETS

Suddenly space became cheaper to access

Futurists, novelists, and filmmakers have long portrayed a confident vision of humans unstoppably conquering outer space. The harsh truth is that since humans first went to the Moon, space access capabilities have largely remained unchanged in terms of both performance and costs… until recently. With few exceptions, launch costs have stubbornly remained fixed around USD 10,000 per kilogram to LEO when adjusted for inflation, whether measured across time, launch vehicle size, or country of origin. The arrival of SpaceX changed this dynamic, lowering launch prices to roughly a third of its competitors' costs since the success of its partially reusable Falcon 9 in 2010. What makes SpaceX's rockets so cheap? Reusability of the first stage (booster), a low-cost vertically integrated approach, and a high flight rate to cushion development costs.

As SpaceX's innovations are gradually endorsed by a new generation of low-cost rockets, the barriers to entry in the space industry have fallen, enabling access to a wider range of companies and new use cases. This democratization is fundamentally changing the commercial landscape of space, which has traditionally been dominated by government interests and a select few large players.

FIG 1: THE SPACEX EFFECT: COST OF SPACE LAUNCHES TO LEO SINCE 1960 *(HEAVY AND MEDIUM CLASS, INFLATION ADJUSTED)*



Source: CSIS Aerospace Security Project

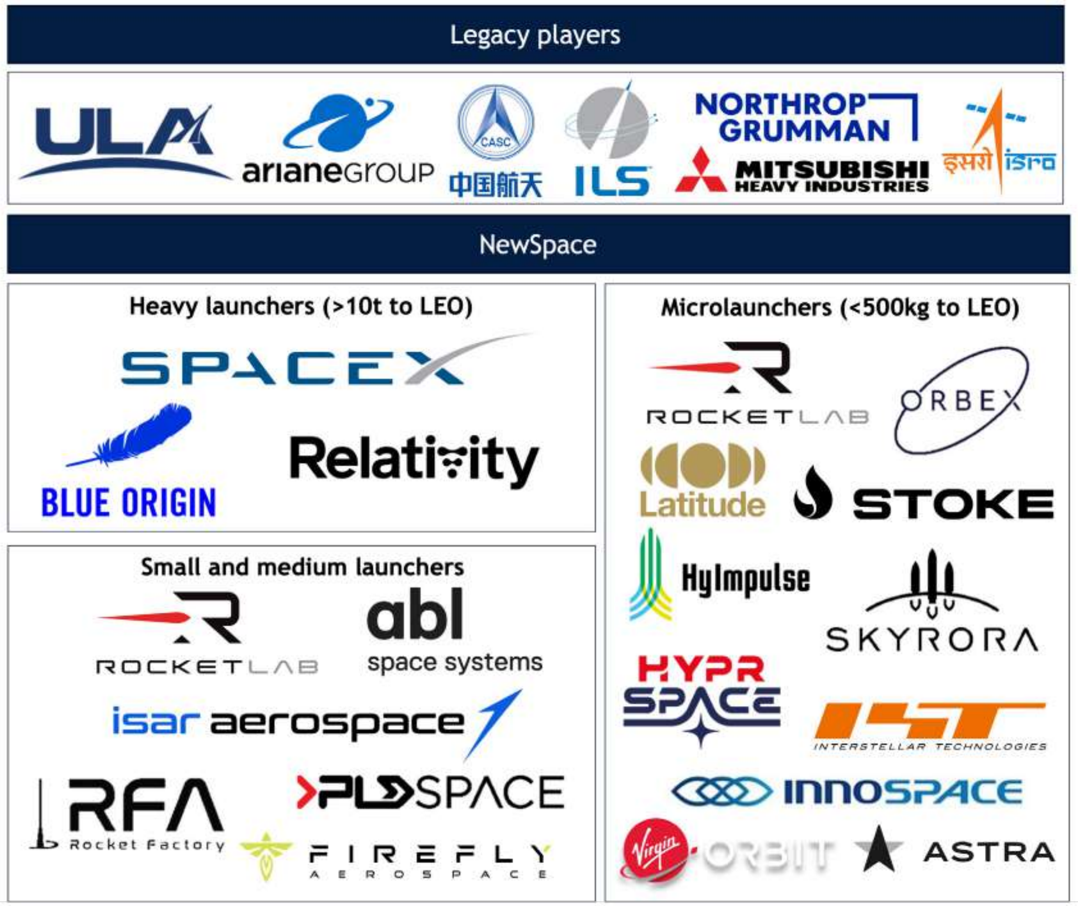
Renewed interest in rocketry promises new game changers

Further reductions in launch costs are expected from the advent of truly reusable rockets, increased competitive pressure and innovative manufacturing processes, including additive manufacturing and modular designs. In the past decade, commercial launch was dominated by heavy-lift vehicles such as Ariane and Proton (~20t to LEO) and medium-lift vehicles such as Soyuz-2 (~8t to LEO). But the offer of launch services is now widening, catering to both significantly smaller and significantly larger payloads:

- Small and microlaunchers designed to carry much smaller payloads are burgeoning. Although microlaunchers have higher launch costs per kg than heavier launchers, they provide small satellite operators with significantly greater launch flexibility compared to rideshares, offering more control over their business plans. Dozens of companies are currently developing microlaunchers, capitalising on potential market opportunities after the industry's shift to smaller satellites. The size of the market will eventually depend on the tradeoff between costs and flexibility, but the sector enjoys government support as 'tactically responsive launchers' are seen as critical tools for the military to rapidly replace satellites during times of crisis. Rocket Lab is currently the market leader with its Electron rocket (up to 300kg to LEO), while Europe has yet to successfully launch its own. Start-ups are targeting the market for ever smaller payloads, such as Latitude's Zephyr, designed for payloads under 80kg. Microlaunchers can also serve as a testing ground for disruptive rocket technologies that could be scaled up to larger launchers in the future. For instance, while rocket technology is presently dominated by either liquid or solid propellant engines, HyPrSpace is pioneering a hybrid-propelled microlauncher, which has the potential to be a more cost-effective and eco-friendly solution.

- The other way around, the 2020s should see the return of super-heavy lift launchers (more than 100t to LEO), the class of rockets capable of taking crews to the Moon… none of which are operational since the retirement of the Apollo program's Saturn V in 1973. SpaceX promises to decimate launch costs once again with the fully reusable Starship (100-150t to LEO). The rocket is participating in NASA's Artemis program to return humans to the Moon by 2025, but there is no doubt that SpaceX intends to make wider commercial use of the biggest rocket ever built. SpaceX tested the complete Starship rocket last April for the first time. The rocket passed MaxQ before exploding mid-air - but it was widely expected for the initial launch to experience some setbacks. Although Starship is unlikely to meet Elon Musk's far-fetched timelines, its reusability, cost-effectiveness, and unmatched payload capacity have the potential to make it a complete game-changer. *'At SpaceX, we specialise in making the impossible merely late.'*

FIG 2: MAPPING OF LAUNCH COMPANIES



*Source: Stifel**

INTERVIEWS WITH INDUSTRY LEADERS

Daniel Metzler, CEO of Isar Aerospace

As one of Europe's most advanced players in the NewSpace industry, and potentially the most advanced when it comes to launchers, what is your ultimate goal? Do you see yourself as the European SpaceX, taking the lead over established players?

Our goal is not merely innovation for the sake of it. When we look at the planned constellations, it's increasingly evident that the future will witness the launch of many smallsats, with ambitions growing massively. But everything starts with getting access to space, and there is a pressing need to drive down costs and increase scale. The key difficulty in space in the coming years is to solve this industrialization challenge.

Previously, the emphasis was on technology. Just five years ago, the industry was building only a few satellites, but now we are already looking at constructing hundreds. Our current focus lies in manufacturing: increasing efficiency and driving costs down.

Your specialization lies in payloads weighing a few hundred kilograms. Is this where you see the largest addressable market?

Indeed, when we look at low orbits where the number of satellites is growing massively, there is no need for multi-tonne satellites. Also, small CubeSats tend to offer only limited capabilities due to size constraints, and customers are now demanding more sophisticated payloads (higher resolution lenses, propulsion…).

As a result, we believe that payload weights ranging from 80kg to several hundred kilograms will represent the majority of launches. This is already the trend we are observing: last year, about 90% of the satellites launched were smallsats (less than 600kg). However, launching several satellites at once is often required, which is how we arrived at our capacity of a bit more than 1 tonne to LEO.

FIG 3: OVERVIEW OF LEADING LAUNCH VEHICLES FOR COMMERCIAL USE

Source: Stifel. Launch prices are estimates*

You've chosen an extensively integrated model with most technologies developed and built in-house, and no emphasis on reusability. Can you explain your design choices for achieving the most cost-effective launcher?

Our strategic choice revolves around industrialising high-cadence rocket production. The traditional aerospace supply chain is costly due to its length and numerous intermediaries. However, if you want to be disruptive, you need to think differently. By vertically integrating, we can streamline the process and achieve significant cost savings. The idea is a factory where raw materials enter on one side, and rockets exit on the other.

When you are solely an integrator, it is challenging to incorporate all the new technologies you desire and automate the production. To truly optimise the production process, you need to design and manufacture hardware parts. That's why we decided to bring most of our manufacturing in-house, significantly reducing costs.

Regarding reusable rockets, we are not opting out entirely. While our first rocket will not be reusable to expedite our time to market, we have designed it from day one with reusability in mind. Cost reduction is driven by two factors: reusability and manufacturing efficiency. We chose to start with the manufacturing aspect as it is more difficult to change, while reusability can be incorporated more easily at a later stage.

What is your target launch cost per kilogram, and how do you plan to compete against massive launchers such as SpaceX's Starship, which claims launch costs below 1000 USD/kg?

We are looking to cut costs significantly compared to the current market rates. Our target launch cost per kilogram is to be below 10,000 USD/kg, which is less than half the price of Rocket Lab's launchers today.

Massive rockets like Starship are indeed cost-efficient for certain payloads, but they lack the flexibility to cater to all types of missions. The public launch price for rideshare on Falcon9 is 6,500USD/kg, not so much below our price target while its lacks flexibility for smallsats. Notably it only launches to specific orbits, so the satellite must go to the correct orbit by itself. Starship will be even worse, they won't care about a 100kg satellite. To many smallsats customers, our launcher's cost-effectiveness and the ability to deliver tailored solutions will be more attractive.

What are the next steps in your roadmap and the status of your launcher's development?

We have conducted most of the qualification testing for our systems and subsystems, and we are currently building the first rocket. We now plan to proceed with launch tests from Norway, with our first launch expected to take place later this year. As part of a European program, this inaugural launch will host four payloads, even if it's primarily a test launch.

Considering your target of achieving 40 launches per year, how do you plan to scale up production facilities?

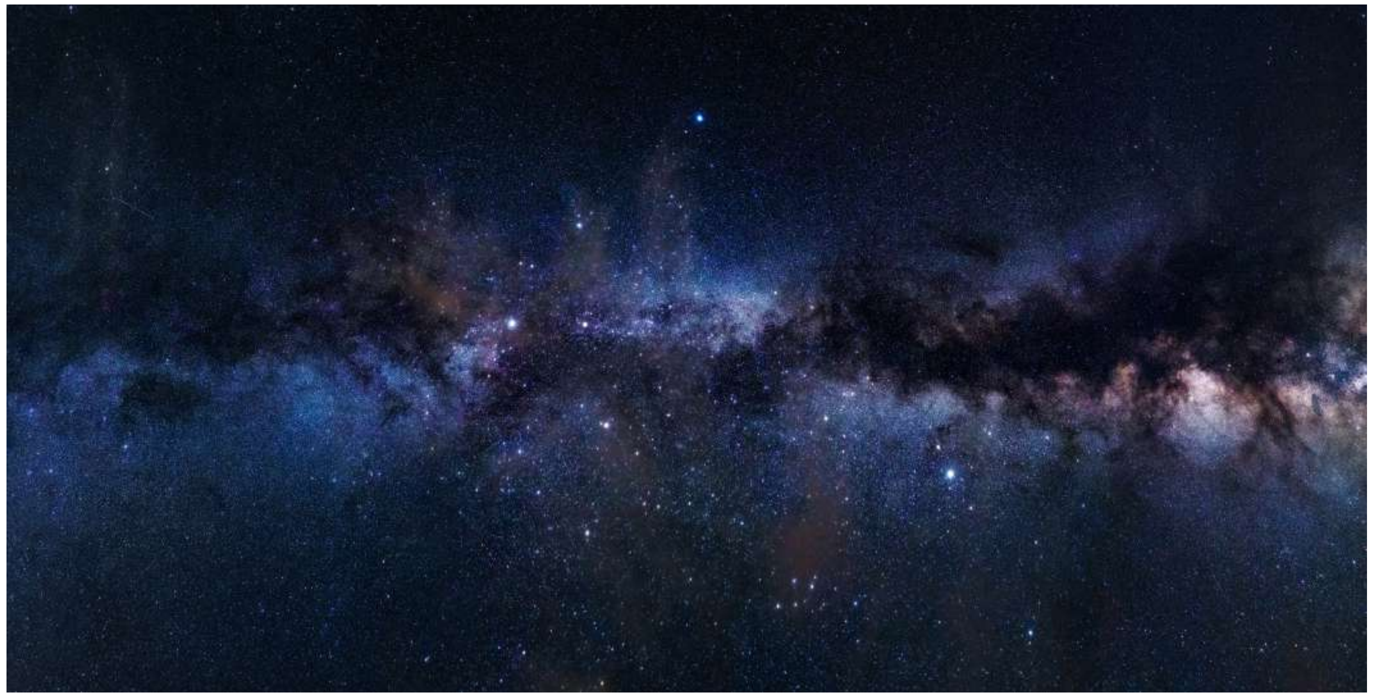
Our production facilities are designed with scalability in mind and are highly automated. Currently, we have around 50 people on our shop floor, already capable of producing two engines per week. We won't need many more people to reach full utilization of our machinery.

Our current funding will get us through the first flights. To reach full production capability, we'll need additional fundraising. Our ramp-up will then be primarily driven by our efforts to scale launch operations.

Given that launchers are highly capital-intensive and strategic assets for Europe's sovereignty, could you discuss the importance of governmental support for Isar in terms of financing and public order?

Governmental support not only provides financial assistance, but it also acts as a «quality stamp». We are already actively working with the European Space Agency (ESA), with contracts already in place. Having ESA as an anchor customer gains the trust of potential commercial customers and other governments. But it's not only about the government supporting us, it is also about us supporting the government

Governments will require greater launch capabilities in the future, and the current reliance on US-based launch services limits Europe's autonomy. Presently, there are no European rockets that can fly at short notice, and flying with US rockets also forces you to disclose some confidential satellite capability information design. Europe must diversify the supply chain and develop its own launch capabilities, it's crucial for sovereignty. That's a huge opportunity for us as a European player.



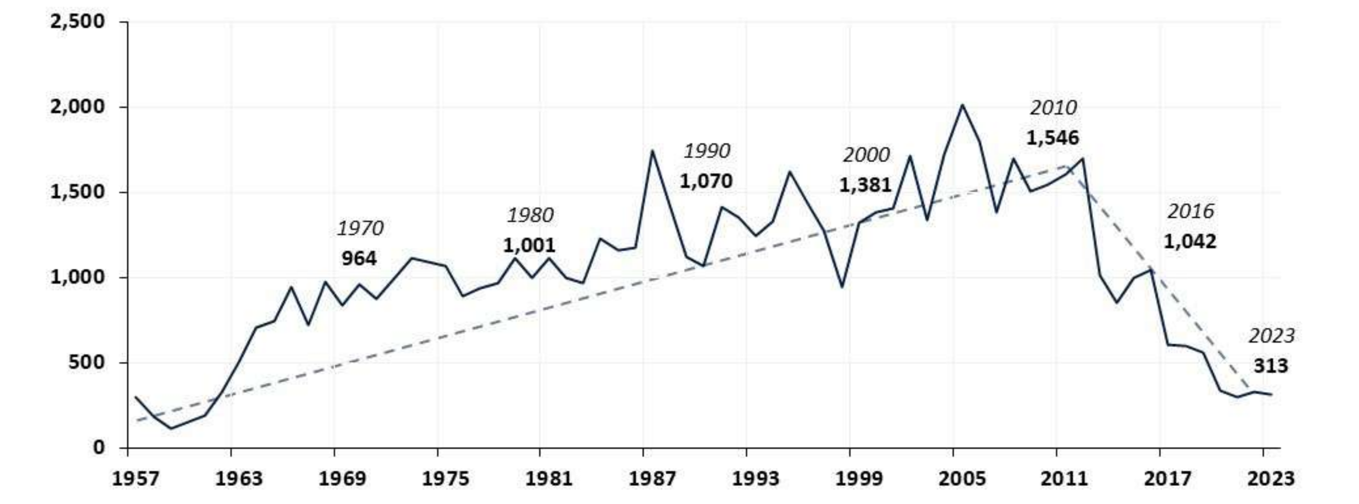
1.2 SMALLSATS CHANGE **THE EQUATION**

Small satellites, big impacts

Large satellites (between one and ten tonnes) are the traditional workhorses of the space industry, as satellites have typically become more complex and massive with time. During the 2010s, large satellites made up about 90% of the total upmass launched into space according to BryceTech.

While historically relegated to technology demonstrations and academic research, smallsats (usually defined as spacecraft with a mass of less than 500kg) have however emerged as a mainstream platform to perform space missions in recent years. For the first time in 2022, smallsats made up the majority of the total upmass launched into space, and over 95% of the satellites launched in 2022 were smallsats. Reduction in the average mass of satellites should continue in the coming years, with an increasing number of smallsat missions being planned and launched.

FIG 4: YEARLY AVERAGE SATELLITE LAUNCH MASS SINCE 1957 *(IN KG)*



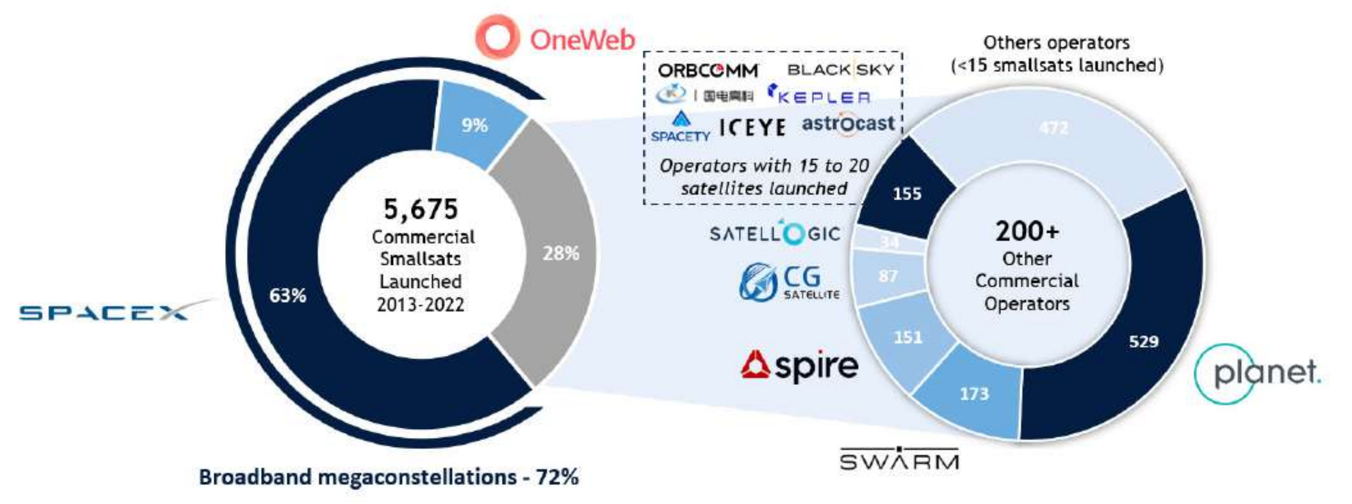
Source: Stifel based on data from Jonathan C. McDowell, General Catalog of Artificial Space Objects (GCAT)*

One of the primary reasons for the widespread adoption of smallsats by new players in the space industry is their cost-effectiveness: they are typically about 100-1,000 times cheaper to build and deploy than traditional satellites. Additionally, smallsats have a shorter development time and lifespan (2-7 years compared to 15+ years for traditional large satellites), accelerating the rate of technology adoption in the satellite industry. However, we anticipate that the average mass of smallsats will trend upwards as a result of the pressure to improve the cost efficiency and performance of space infrastructures. This trend is exemplified by the Starlink Gen-2 satellites, which are expected to weigh 2.5 to 5 times more than the Gen-1 satellites, or the new, heavier buses of the Airbus Arrow platform.

The small satellite landscape has been shaped by a select few large constellations thus far. By the end of 2022, only seven operators had successfully deployed over 20 smallsats into orbit. 88% of all commercial smallsats launched since 2013 can be attributed to just five operators, with SpaceX leading the pack, accounting for over 60% of the total single-handedly. This remarkable concentration of numbers primarily reflects the rise of broadband «megaconstellations» like Starlink and OneWeb. While we anticipate witnessing a more diverse distribution of smallsats among various constellations in the future, the dominance of megaconstellations in terms of sheer numbers is likely to persist over the decade: Amazon Kuiper looms on the horizon, and both Starlink and OneWeb plan to launch second-generation constellations.

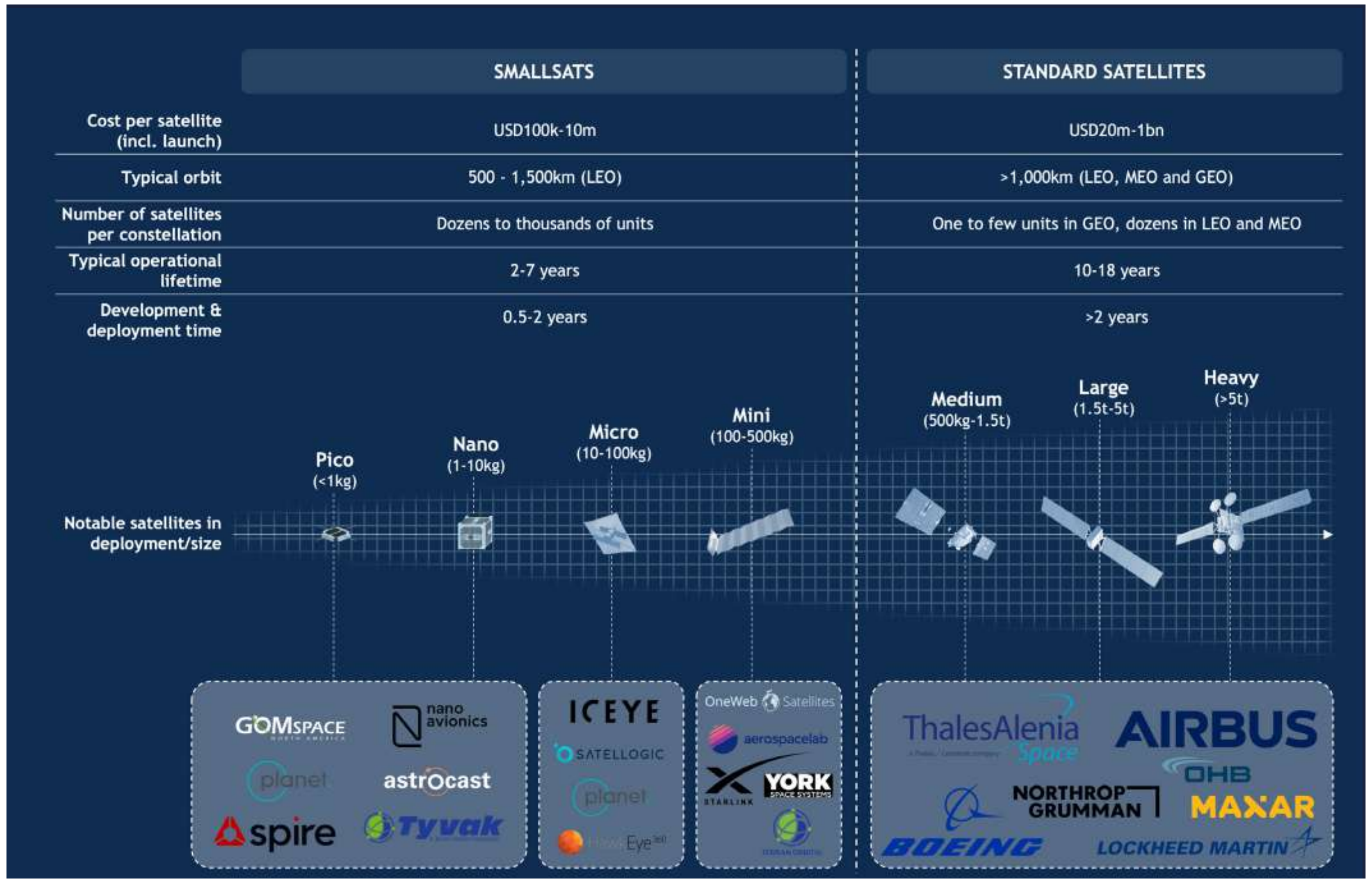
FIG 5: COMMERCIAL SMALLSATS ARE THE REALM OF A HANDFUL OF OPERATORS

(LAUNCHES OF SMALLSATS BY OPERATORS, 2013-2022)



Source: BryceTech, Smallsats by the numbers 2023

FIG 6: SMALLSATS VS STANDARD SATELLITES



Source: Stifel.*

The thrive of smallsat manufacturing

Low-cost launch options such as rideshares helped unlock the economic potential of smallsats. However, the surge in popularity of low-cost smaller satellites can also be attributed to a wave of startup satellite manufacturers applying new technologies and manufacturing processes:

- Smaller form factors achieved through electronics miniaturisation and new propulsion technologies

- A preference for COTS (components off-the-shelf) to reduce the use of expensive space-grade components

- High-volume and modular manufacturing techniques such as the CubeSat standardisation. Many NewSpace companies specialising in smallsat platforms and turnkey solutions have emerged, such as Loft Orbital or Andurosat

The burgeoning interest in constellations is propelling a rapid transformation in satellite production: the larger series of satellites call for new manufacturing processes and new paradigms for tests and qualifications. This sense of secular pivot to smallsats has caught the attention of prominent defence contractors who are now looking to gain market share in key smallsat manufacturing technologies, including through acquisitions. A typical example is the involvement of large European primes such as Airbus and Thales Alenia Space in the new constellations (Iridium Next, Blacksky Global, OneWeb, Telesat Lightspeed).

According to Euroconsult, smallsats are projected to account for about 20% of satellite manufacturing revenues between 2022 and 2031, displaying double-digit growth that outpaces the rest of the market. Governments, expected to account for nearly three-quarters of total satellite industry revenues throughout this decade, will also play a significant role in driving demand for smallsats through the launch of sovereign constellations. It is worth noting that a substantial portion of commercial smallsats may not be accessible to third-party satellite manufacturers, as major operators have established their own in-house manufacturing capabilities - notably SpaceX with Starlink and Amazon with Kuiper.

Historically dominated by chemical propulsion and aerospace giants, the spacecraft propulsion market has also been blossoming in recent years. Propulsion has become increasingly important for smallsats, enabling them to attain their desired orbits, a key feature given the exponential growth of ridesharing practices. Propulsion also plays a vital role in elongating the operational lifespan of small satellites by countering the inevitable decay of their orbits over time. In addition, smallsats equipped with propulsion systems can actively avoid potential collisions by manoeuvring away from space debris or other satellites. New entrants are capitalising on electric propulsion, more adapted to smallsats and the need for agile spacecraft, especially in the defence realm. Improved efficiency through electric propulsion is also becoming the standard in large telecommunication satellites to increase the payload-to-mass ratio, as seen with VHTS (Very High Throughput Satellites).

FIG 7: MAPPING OF SATELLITE PLATFORM PROVIDERS

*Source: Stifel**

INTERVIEWS WITH INDUSTRY LEADERS

Emile de Rijk, Founder and CEO of Swissto12

In 2011, Emile spun out Swissto12 from EPFL (Swiss Federal Institute of Technology in Lausanne). Under his leadership, the company has grown to become a leading provider of Radio Frequency solutions for high-throughput satellite communication applications with over 1,000 products in space at geostationary orbit and the world's largest IP portfolio in RF products and solutions built using 3D printing.

In 2022, Swissto12 became the first ever scale-up company to sell a geostationary telecoms satellite -named HummingSat after the small, light and agile bird - to a global satellite operator. To date, Emile has co-invented 20+ patents, raised equity capital from prestigious European investors and signed €300m+ worth of commercial contracts with leading aerospace and telecommunication customers for the delivery of RF products & solutions as well as HummingSat.

You are a well-known provider of RF products for aerospace and telecommunications applications, but you have also developed the world's first GEO smallsat. While many NewSpace companies are highly focused on LEO, please tell us about the opportunities you see for smallsats in geostationary orbits.

RF communications have defined the modern era, but demand is outgrowing capacity.

The press has recently given a lot of focus on how broadband Low-earth Orbit constellations plan to address this opportunity. But today, LEO is still a comparatively expensive way to deliver broadband connectivity. Launching a constellation to deliver global services requires hundreds, if not thousands, of satellites, a large network of ground stations and complex equipment with every end user to track the movement of the LEO satellites for users.

In contrast, GEO satellites are stationary relative to users, which makes it easier and cost effective to connect to them, while the unit economics of the GEO satellite investment provides the most competitive unit economics for connectivity services from space. Each GEO satellite can potentially deliver services to one third of the earth. Although GEO is much more cost effective than LEO, GEO has traditionally been serviced by large assets, often costing 200m$ to $500m per satellite program and requiring a dedicated launch. This high CAPEX per GEO mission has historically meant that only large and long-term market opportunities can be addressed. Smaller regions, and niche market applications, incremental market developments, and gap filling applications have been under serviced by GEO for this reason.

Why not address these opportunities with a SmallSat? That is a question we asked ourselves at Swissto12. For over a decade, we have pioneered the use of 3D printing for Radio Frequency products and payloads (communications antennas, receivers and transmitters). Currently, there are over 1,000 Swissto12 products in orbit on operational satellites mostly in GEO but also with some of our customers operating in LEO. The next logical step for us was to leverage these payload advantages in a more agile, SmallSat for GEO.

One problem is that, as satellites get smaller, so does the cost efficiency of capacity. How do you manage to overcome this issue with your proprietary technology?

Swissto12's first-of-its-kind GEO SmallSat, HummingSat, is roughly the size of a large kitchen fridge, compared to traditional GEO satellites which have a similar mass to a large van. Our mission is to reinvigorate GEO by making it possible for telecom operators and service providers to address a new class of previously underservices opportunities out of GEO. These include regional markets, cost effective replacement satellites for ageing assets, gap-filling missions with applications across broadband, broadcast, safety and positioning services in an agile and cost-effective way.

The key to HummingSat's performance is Swissto12's proprietary 3D-printed payload technology. These components allow us to build on a smaller, lighter scale, with higher density of payload capabilities per unit mass and volume. Owing to its small platform size, HummingSat can rideshare on existing satellite launches which massively reduces the cost of launch and positively impacts the mission unit economics. HummingSat preserves a reasonably similar dollar per megabit per second per month cost of connectivity as compared to legacy larger GEO satellites, but in a much smaller, much lower unit cost satellite, which can deliver a throughput of up to 50 gigabits per second of data.

Because they are small and lightweight, HummingSats are both more affordable and quicker to build. HummingSats can also offer a competitive replacement option for many legacy geostationary satellites that have reached the end of their lifetime or for governments to invest into sovereign secure connectivity over satellites.

HummingSat also has multiple payload evolutions we are working on, from traditional analog "bent pipe" systems to fully digitally processed and defined payloads for optimal flexibility of coverage and of service. We adapt this to the individual needs of every telecom operator customer and we work with them to adjust the payload to their exact requirements to be as optimally close to their mission profile and business case.

So, you believe that GEO has a brighter future than some think. Please tell us more about your Hummingsat clients and use cases.

To date, we've secured deals for HummingSat from Intelsat and Inmarsat, two of the leading blue chip satellite operators who have led and shaped this industry since its inception. After our deliveries in 2026 and subsequent launches, there will be 4 HummingSats in geostationary orbit and by 2030, we aim to have grown the fleet to more than 10 Hummingsats, enough for our customers to provide ubiquitous global coverage, so they can better connect and protect people worldwide.

Specifically, Intelsat will launch a Ku-band FSS BSS mission using HummingSat, whilst ViaSat owned Inmarsat will launch three L-band HummingSats, to strengthen its safety services for 1.6 million mariners, 200 airlines, governments and space agencies. HummingSat's novel radiofrequency payload for Inmarsat, in orbit 35,768 km above earth, will also give coastguards, air traffic controllers, and other safety services more accurate GPS, increasing precision from 5-10 meters to as little as 10 centimeters.

Intelsat and Inmarsat are themselves amongst the most respected global operators and pioneers in geostationary communications. These orders – global satellite operators buying from a growing company such as SWISSto12– are ground-breaking in themselves, quite apart from the technology involved. GEO is dominated by large, established players and no younger growing company has ever penetrated the GEO satellite market in this way before. So yes, you could say I am bullish about the GEO opportunity for our SmallSats, but our recent deals with Intelsat and Inmarsat show the market is too.

Do you see yourself as a competitor to larger incumbent satellite manufacturers?

We don't see HummingSat as a competitor to conventional larger GEO satellites. HummingSat is opening market opportunities have not been addressed by large GEOs because of the unit cost of these larger missions. Customers who have a business need for such a large GEO satellite and mission will naturally buy such a large satellite. Furthermore, many large GEO satellite manufacturers are themselves either our customers, using Swissto12 RF components and subsystems in their payloads, or our suppliers by provisioning products and subsystems for our Hummingsat platform.

We differentiate through our business model from other emerging players marketing smaller satellites in GEO in that we build GEO SmallSats and sell them to satellite operators who own and operate them.

As a Swiss company, do you face headwinds compared to companies from the EU, which have access to a wider range of support? Financing, market access, public order... Globally, how does Switzerland stand in the European Space ecosystem?

Switzerland has a long-standing global reputation for quality, precision engineering, reliability and political/economic stability. When you combine this with our access to capital, it's not surprising that the latest Innovation rankings place Switzerland as the most innovative country on the continent. This heritage has been built on in recent years by Switzerland's excellent education and research ecosystem. Swissto12 spun-off from the Swiss Technology Institute of Lausanne in 2011, which is one of the highest-ranking European universities.

Switzerland is a founding member of the European Space Agency (ESA) and has a longstanding heritage in providing key products for space missions, dating back to the Apollo program. At Swissto12, we've benefited greatly from our partnership with ESA which helped us initially to develop our 3D printed RF product lines, and now develop and commercialize HummingSat. From funding and R&D, to unlocking commercial opportunities, our ESA partnership has meant we've been able to scale our technology and market outreach much faster - they have been a powerful catalyst for growth and collaboration.

As a Swiss based company, we're very proud to have been able to generate a very successful and high growth business with operations in Europe, the United States and Israel and leading international blue-chip customers entrusting us with business for our RF products and HummingSat. In summary, Switzerland is a great place to do business.

Could you share with us the next steps for Swissto12? How much do you intend to raise your production capacity? Are you contemplating the launch of new products, perhaps in LEO, for example?

We still have a lot to do in GEO communications. Our top priority is to deliver the satellites we've been entrusted with by our existing customers and through these initial successful deliveries, grow a recurring business of many HummingSat satellites a year, which is validated by the interest we receive from operators in the industry. We are not planning on launching a dedicated LEO satellite platform, we focus on supporting customers building satellites in LEO with our RF and payload products. There's certainly the mid to long term possibility to use this technology and deploy connectivity to the moon. With the Artemis program, this frontier is moving closer and has the potential to be an exciting new application arena for Swissto12 in the future.

1.3 THE REINVENTION OF THE SPACE INDUSTRY UNDER **NEWSPACE**

NewSpace, New Mindset

Development of commercial space and start-up space ventures is one of the most visible trends in space, known as NewSpace. Gaining critical mass around 2010, NewSpace is characterised by rapid innovation and the growing role of private investors, particularly venture capital, in the space industry. NewSpace has brought with it a set of drastically different approaches and business practices, inspired by methods from Silicon Valley. At the core of the NewSpace philosophy is the belief that there is untapped potential in commercialisation and democratization of space activities. As a result, NewSpace has focused on the development of «Space-as-a-Service» offerings and expansion of the private, often non-space demand in an industry that has traditionally been dominated by the public sector and government interests. The growing role of the private sector in space is receiving strong government support to promote innovation and cost reduction in an industry undergoing an upsurge of geopolitical competition, amidst US-China tensions and record investments in space militarisation.

NewSpace companies abandoned many traditional space and aerospace models in favour of what can be characterised as an agile software approach from Silicon Valley, where the first NewSpace start-ups were born: go fast, fail if necessary, and advance through iterative processes. NewSpace will deeply and durably affect the habits of the space industry.

Incumbents and public agencies have a historically low tolerance for risk: «Failure is not an option». In contrast, NewSpace is characterised by much higher risk-taking models, seeking disruptive innovation to create a new market and/or displace established market leaders. The differentiators are both the technologies and the company «mindset»: focus on services, increased use of commercial off-the-shelf (COTS) components, standardisation, new approaches to reliability, incremental deployment («walk before run»), revised methods inspired by software development, co-design with customers and suppliers, flat and agile organisations.

FIG 8: THE SILICON VALLEY APPROACH APPLIED TO SPACE

NEW SPACE		TRADITIONAL SPACE
Low-cost, short-lifetime model		High-cost, high-quality model
Software driven		Hardware driven
Focus on services	VS	Techno push
Standardisation, mass production		Customisation
Higher tech and business risks		Risk averse

Source: Bryan, Garnier

COMPANY FOCUS

leanspace

Leanspace stands out as one of the rare software-focused entities within the European NewSpace sector. As Software-defined and reconfigurable satellites take center stage, the ground segment assumes paramount importance. However, it remains an intricate domain that frequently gives rise to delays and cost overruns. In light of these challenges, Leanspace has developed a platform with the aim of streamlining the ground segment in a profound manner. By providing developers with a suite of APIs, this platform enables the construction of scalable cloud-native systems for satellite Command and Control, Mission Planning, and Flight Dynamics. It facilitates seamless integration of essential functions of space software, such as data management, security, and connectivity, sparing the need to build software from scratch or rely on inflexible off-the-shelf solutions. Operating on a PaaS model, Leanspace caters to the requirements of NewSpace companies, as well as established satellite operators, launchers, ground station operators, and in-orbit service providers. The Leanspace platform extends its focus beyond operations, encompassing engineering, test benches, control centers, and other aspects. This holistic approach aims to break down traditional silos within the space industry, ensuring integrated end-to-end management across all phases of space missions, from design to operations.

Toward faster innovation cycles

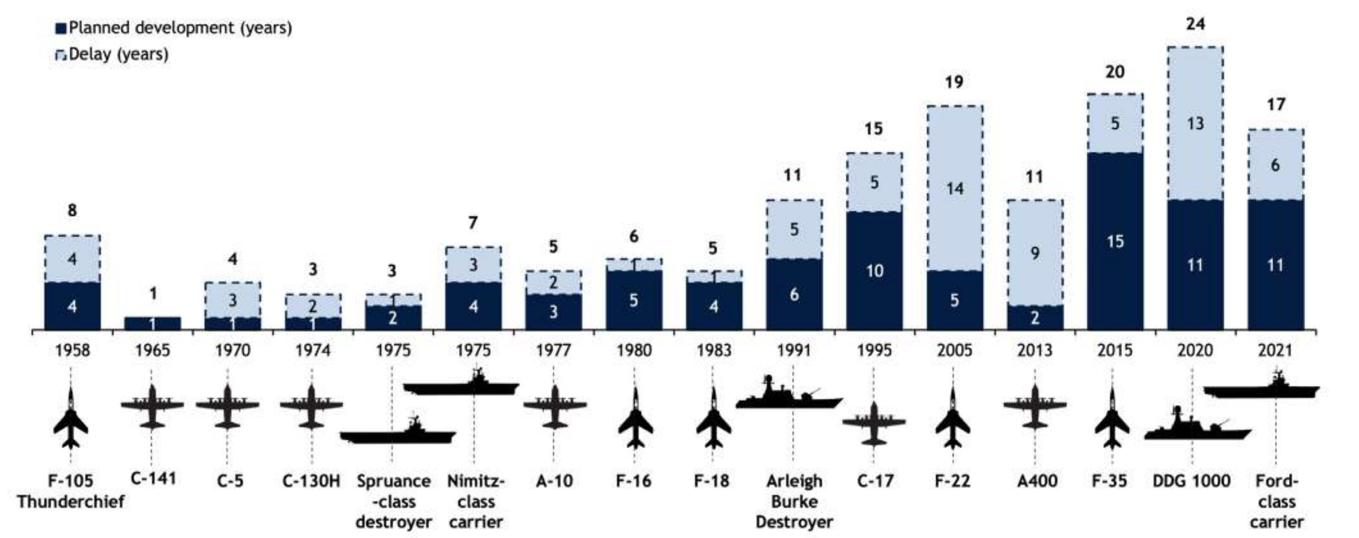
While the space industry is commonly regarded as a vanguard of high technology, much of the technology employed in satellites launched over the past few decades can be considered somewhat outdated. The prolonged lifespan and stringent reliability requirements not only contribute to the relatively old average age of satellites but also foster a natural risk aversion among manufacturers, leading to hesitation in incorporating new technologies into their production processes until they have established confidence in the component's ability to operate effectively in the demanding space environment for an extended period. Consequently, the adoption of new technologies in satellites has typically been slow, but things are changing with NewSpace.

Under NewSpace, pressure to innovate is mounting sharply. Constellations will likely introduce much quicker renewal cycles as LEO satellites have lifespans of 3-7 years, as opposed to the 15-18 years typical of GEO satellites. Shorter lifespans provide operators an opportunity to upgrade their satellites more frequently, each time ushering in greater efficiency enabled by rapid technological innovation and a steepening hardware downward cost curve compared to incumbent players. The adoption of software-defined hardware allows operators to remotely upgrade their satellite networks, without the need to relaunch satellites.

NewSpace appears as a breath of fresh air in the global aerospace and defence industry, which is struggling with execution and increasingly lengthy development times, often resulting in budget overruns and the deployment of outdated equipment. The root causes of these long innovation cycles in A&D are multifaceted. Every leap in tech makes the next one harder and sustaining a technological gap with competitors, or competing nations, is becoming increasingly challenging. Also contributing is the growth of outsourcing that introduces complexity into the supply chain, as well as legacy project management methodologies that are less suited to the current climate of risky innovation and increasing complexity in software development. By adopting agile methodologies and higher vertical integration, NewSpace companies prioritise timeliness and cost-effectiveness in their development processes, offering an alternative to avoid the pitfalls often faced by the incumbent space industry.

NewSpace firms have exhibited remarkable dexterity in both R&D and execution. The development of the NASA Space Launch System (SLS) and SpaceX Starship, the two colossal rockets participating in the Artemis moon landing program, has become a clash of ideologies, pitting traditional space approaches against the disruptive methods of NewSpace. The SLS, led by NASA and executed by aerospace conglomerates, follows a traditional path fraught with extensive timelines and exorbitant costs (exceeding USD23bn for five rockets, as of 2022). In contrast, Starship embodies the rapid, innovative, and cost-effective practices synonymous with NewSpace... though, as of now, it has yet to reach orbit. In the realm of satcoms, SpaceX's swift deployment of its Starlink constellation has dealt a significant blow to established operators, who are themselves grappling with considerable delays due to Covid-related disruptions in their supply chains. This has led to multiple launch postponements for prominent constellations like Viasat-3 by Viasat and mPOWER by SES. We believe that the incumbent operators were caught off guard by Starlink and now confront an existential challenge from the rapid innovative abilities of new entrants. From our perspective, the merger announcement between Eutelsat and OneWeb can be seen as a defensive move, an implicit recognition that the future of satellite communications has tilted towards the technologies embraced by these disruptive newcomers.

FIG 9: DEFENCE PROGRAMS ARE FACING INCREASINGLY LONG DEVELOPMENT TIMES



*Source: Stifel**

THE RISE OF **LEO CONSTELLATIONS**

SECTION 2

The space industry is witnessing a paradigm shift with regard to the number of rocket launches and operational satellites, setting new records annually. This transformation is primarily driven by the rapid expansion of low-Earth orbit constellations, which are fundamentally reshaping the outer space landscape. Two sectors stand at the forefront of this revolution: satellite telecommunications, which are witnessing the rise of broadband megaconstellations, and Earth observation, fueled by a growing demand for satellite data.

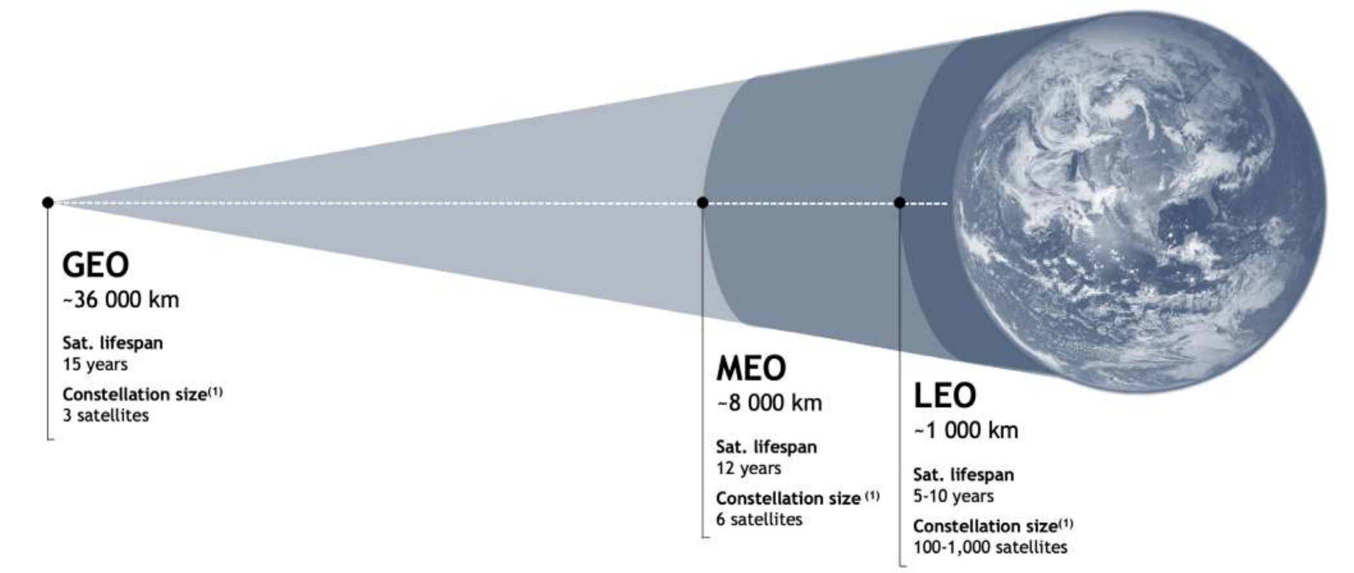
2.1 AN UNPRECEDENTED PROLIFERATION OF **HARDWARE IN SPACE**

When small things build large systems

Scaled-down satellites have resulted in the proliferation of scaled-up massive constellations. For decades, satellite operators have favoured single-satellite missions due to prohibitive launch costs and zero-risk processes that called for heavy satellites with redundancies and expensive space-grade electronics. The 1990s and 2000s had seen a first wave of constellations for navigation (GPS) and telephony services (Iridium, GlobalStar). Leveraging technological capabilities that made satellites cheaper to build and to launch, NewSpace companies are now deploying constellations of dozens to thousands of smallsats for new use cases such as broadband and Earth Observation. With constellations, the reliability of the system is not dependent on the quality of individual satellites but rather on their quantity: each satellite can be less reliable, thus cheaper and potentially mass-produced. In fact, it has become common practice for operators to incorporate spare satellites to enable the replacement of any defective satellites throughout the lifespan of the constellation, ensuring that the constellation can maintain its intended level of service without interruption or delay.

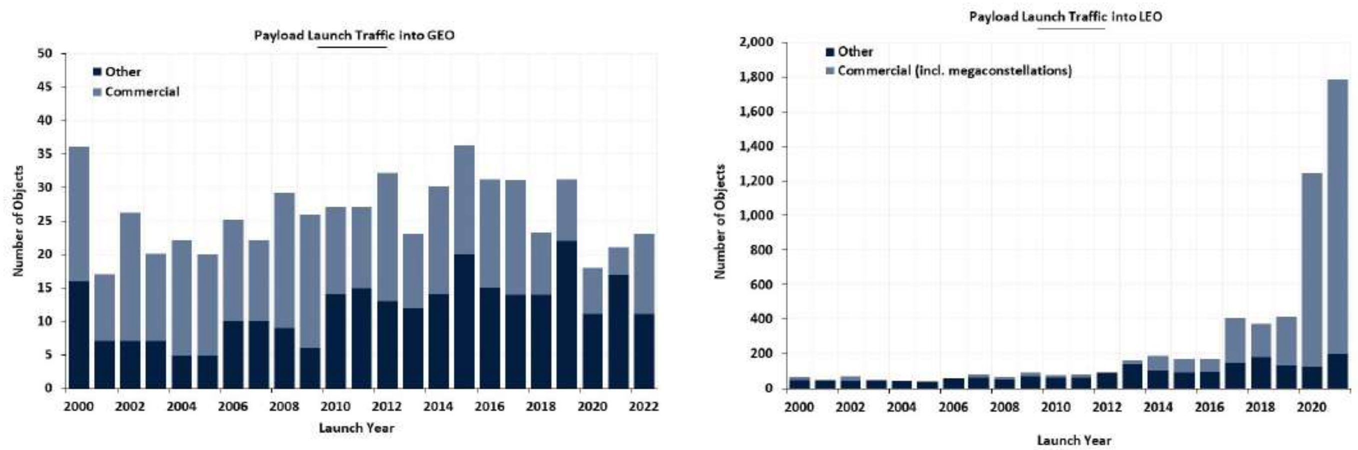
Constellations focus on LEO, where payload traffic has grown exponentially in recent years. Satellites in LEO are often deployed in satellite constellations because the coverage area provided by a single satellite at lower altitude is limited, but also because the coverage of LEO satellites is not fixed over one specific region as, unlike satellites in geostationary orbit, the Earth's rotation speed is different from that of the satellites in LEO. The shift to closer-to-Earth orbits is already happening in today's satcom and Earth Observation markets, where a flood of new entrants are challenging incumbents with innovative constellations. Commercial activity in GEO has already been developed since the 1970s, but the traffic to GEO appears to be plateauing.

FIG 10: MAIN SATELLITE ORBITAL POSITIONS



Source: Stifel (1) Constellation size refers to the minimum number of satellites required for a constellation to achieve global, continuous coverage (satcoms)*

FIG 11: THE SURGE IN TRAFFIC TO LEO IS DRIVEN BY NEWSPACE, WHILE TRAFFIC TO GEO IS PLATEAUING



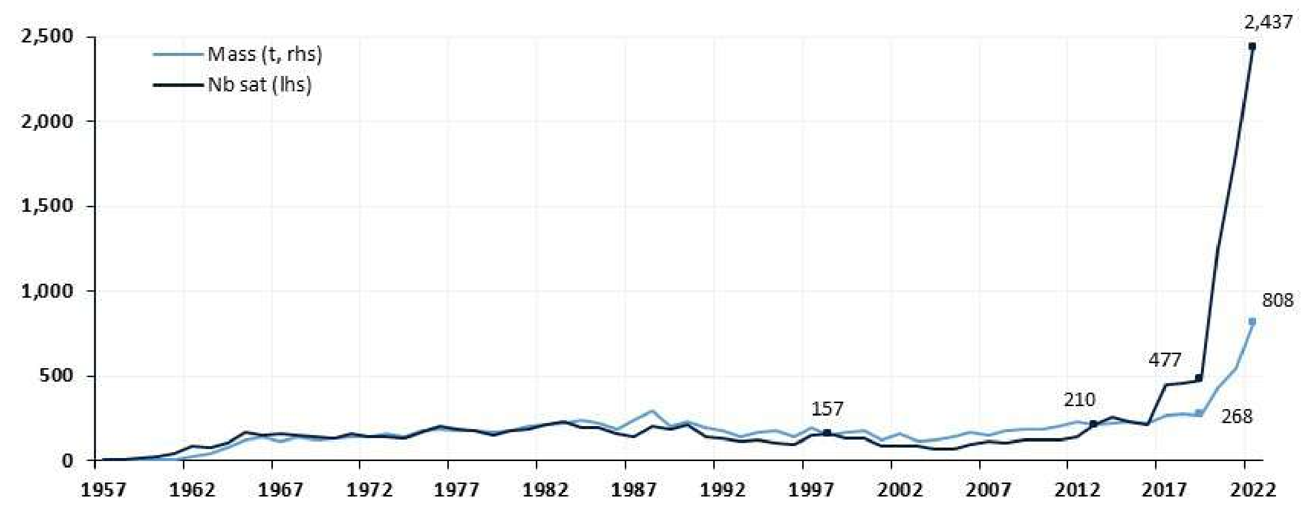
Source: European Space Agency (ESA)

Ongoing satellite launch frenzy

The potential number of satellites launched into orbit by 2030 could reach tens of thousands, a significant increase compared to the ~2,500 launched during the 2010s. Since the Sputnik was launched more than 60 years ago, about 15,000 cumulative satellites have been placed in orbit as of March 2023. Satellites launched in the past five years already account for about 50% of them. So called megaconstellations such as Starlink and OneWeb and other NewSpace constellations are the primary drivers of the increase.

With the advent of more affordable launch options and cheaper satellites, space is experiencing a radical transformation when it comes to the number of satellites launched in orbit. The mass of spacecraft put into space each year grew at a 25% CAGR over the past five years to reach 808t per year in 2022, from 269t per year in 2017. In 2022, 186 successful rocket launches (the most ever) took more than 2,000 spacecraft into orbit, growing the number of operational satellites by about 40% within a year.

FIG 12: ANNUAL NUMBER AND TOTAL MASS OF SATELLITES LAUNCHED EACH YEAR INTO SPACE SINCE 1957



Source: Stifel (1) Constellation size refers to the minimum number of satellites required for a constellation to achieve global, continuous coverage (satcoms)*

INTERVIEWS WITH INDUSTRY LEADERS

Benoît Deper, Founder & CEO of Aerospacelab

Aerospacelab is active both in geospatial intelligence and in satellites components and platforms. What led Aerospacelab to the decision of adopting a vertical integration model with multiple offerings, ranging from satellite manufacturing to data analytics?

The initial vision that led to the inception of Aerospacelab in 2018 was the ambition to establish a multi-sensor constellation. This droves us to not only develop various types of sensors but also to create a versatile platform, with the adaptability to accommodate diverse payloads seamlessly.

The economic sustainability of the Earth Observation (EO) industry also relies partly on cost-efficient constellations. We increased verticalization to achieve substantial cost reductions, in order to have very low costs.

After 5 years, Aerospacelab has gathered expertise in every step of the value chain, developing a strong offer in both platforms and payloads. Demonstrators of our technology are planned for launch this year and early 2024. Today we position ourselves as providers of small satellites, addressing the data market secondly.

You have adopted a multi sensor strategy for earth observation, with constellations mixing both optical and radar technologies. How can you provide state-of-the-art technologies on both, and how competitive can you be against the pure players?

Numerous synergies exist between the different types of payloads. For instance, mass memory storage and control electronics are quite similar across all payload types. Regarding electro-optical payloads, a lot of core technologies are also shared: same design procedures, same manufacturing machines and methods, same AITV setups, same skills...

Please tell us where you stand in terms of your own constellation deployment, and where you foresee the largest areas of growth in satellite data and analytics?

We already have a contract for the supply of data to the Copernicus mission of the European Commission, based on our first multi-spectral satellite. We plan to deploy our multi-sensor constellation and offer the data services in the near future.

You have plans to build a megafactory capable of producing 500 satellites annually. What are the scale effects observed in the manufacturing of large series of smallsats? Do you consider yourselves as disruptive to the established satellite manufacturers who historically focused on low-volume production of large satellites?

The growth of the geospatial economy in recent years has been intricately tied to the the development of private services. Private companies face more pressure on return on investments, which translate into demand for cost efficiency and shorter project timelines. Notably, we have observed a growing preference among private companies for delivery planning periods of less than two years, with an ideal target of one year, from contract signing to in-orbit commissioning. This is the type of schedules found in other sectors, such as industrial equipment and specialised machinery.

Our offer is based on generic units and platforms, with marginal adaptation and high production capacities. Adopting industrial methods coming from other industries is pivotal to guarantee lead-times. Scaling production to high volume will give us the ability to supply big constellations.

Your existing factory produces satellites in the 150-400kg range. What will be the mass of the satellites manufactured in your new facility? Are you planning to target the market for smaller satellites such as Cubesats or do you perceive a structural shift in the smallsat market towards larger buses?

We are witnessing a shift in demand from CubeSats towards microsatellites, driven by declining costs of launches. Microsatellites present the ability to host larger and more advanced payloads, aligning with our strategy centered on agility and responsiveness to market trends. Our forthcoming facility will have the capacity to manufacture satellite buses weighing up to 750 kg. Currently, our medium-sized platform accommodates payloads of 150 kg, and we also offer smaller (50 kg) and larger (450 kg) platforms tailored for satellite communication applications.

For smallsat manufacturers, which market do you believe will present the greatest opportunity between B2G and B2B by the end of the decade?

We see governments or institutions coming into the smallsat markets as well as new private actors trying to find their ways in this new economy. We think our revenues will be equally shared between B2G and B2B.

More than 10,000 operational satellites by 2025e

The commercialisation of low orbits, which were once accessible only to the military and a few aerospace giants, is evident in the exponential growth of operational satellites in recent years. Private NewSpace companies are increasingly populating low orbits with their satellite constellations, and possibly in the future with space infrastructure and space tourism ventures.

In the coming years, we expect the number of operational satellites to continue to rise, primarily due to the broadband constellations being launched by Starlink, OneWeb, and Amazon Kuiper. We estimate that these megaconstellations should account for over 60% of operational satellites throughout the 2020s. Additionally, space militarisation seems to become more and more a fact, leading to the development of new missions such as orbital services and space surveillance. Over the next decade, governments are expected to launch hundreds to thousands of smallsats for various defence applications, particularly in response to the emergence of anti-satellite weapons (ASAT), which have made large satellites vulnerable to such missiles. In this context, large LEO constellations are perceived to offer greater resiliency and redundancy for national architectures.

In other words, owning a smallsat megaconstellation appears a prerequisite for space powers in today's space landscape. We expect to see sovereign constellations being deployed by the United States, the European Union, and China in the 2020s. In 2023, the US Department of Defence launched the first satellites of its Proliferated Warfighter Space Architecture, the US sovereign military smallsat constellation, a pivot that is driving new demand from the defence sector. Similarly, the European Union is planning to deploy the Iris² constellation to provide «sovereign and secure satellite connectivity to government users for security and defence and economic purposes». The project is expected to cost EUR6bn, with both public and private funding. In China, a megaconstellation project named Guo Wang («national network») received official recognition in 2021, shortly after filing an application to the ITU for 12,992 LEO satellites, but the project remains cryptic, and the lack of Chinese reusable launch capabilities should constrain the constellation ramp up.

By 2030, however, we expect this acceleration to slow down and the number of operational satellites to stabilise at around 15,000 by the end of the decade, as the current exponential growth pattern is not sustainable:

- Satellite operators are experiencing a shortage of launch options that should continue until the available launch capacity significantly increases in the second part of the decade.

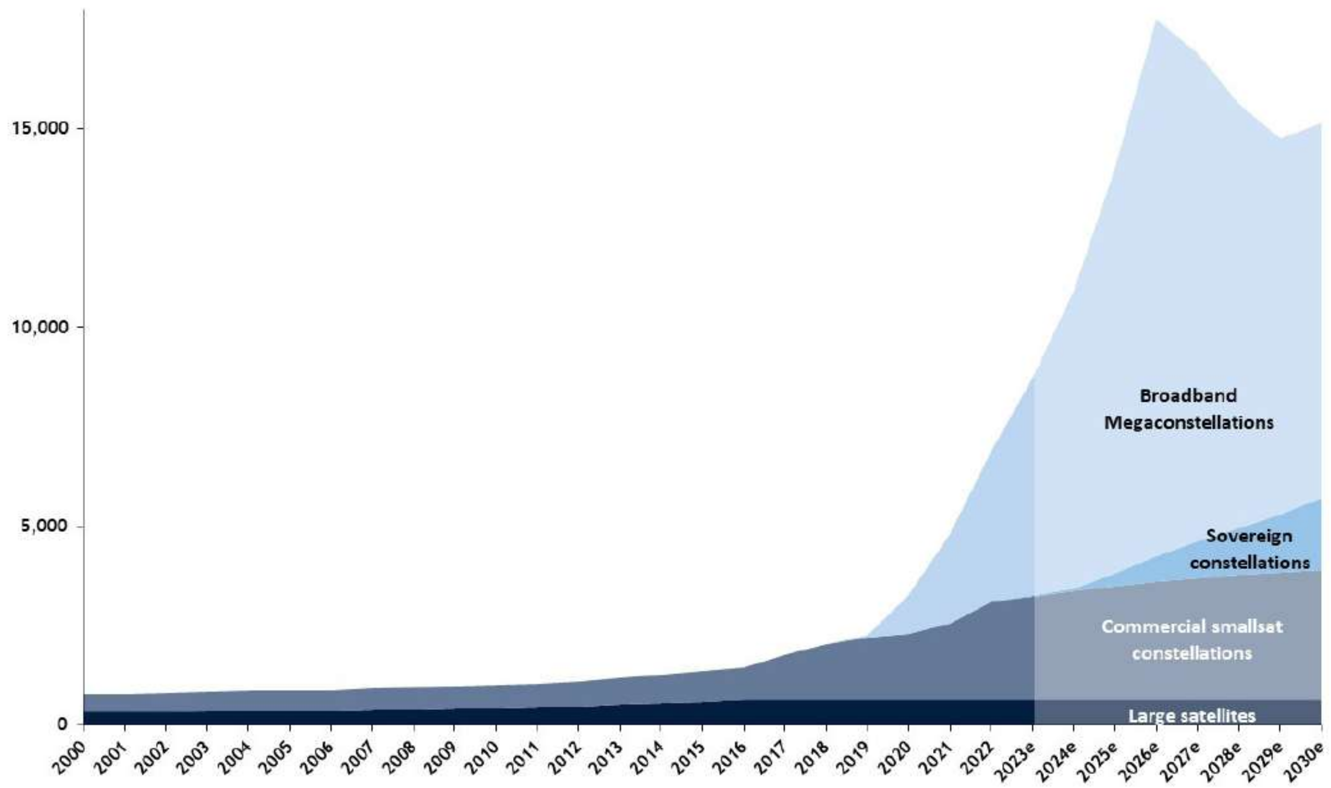
- There will be a need to impose stricter standards to regulate access to space for massive commercial projects. The ever-growing number of satellites and in-orbit debris has been a concern for many experts for years, and megaconstellations, in particular, have come under heavy criticism. There are currently no international regulations in place to limit the number of satellites a private company can launch or the orbits they can occupy.

- A consolidation of NewSpace players should restrict the number of new constellation projects. With the influx of numerous actors in the market in recent years, we anticipate that some consolidation will occur, particularly after the venture capital tightening in 2022.

- The phase of satellite «smallifying» appears to be ending since the mass of smallsats has been trending upwards in recent years. Larger satellite buses (exceeding 100kg) are increasingly favoured over Cubesats.

In our base case scenario for future satellite launches, we maintain a conservative outlook, focusing primarily on SpaceX, Amazon, and OneWeb as the key players in launching broadband megaconstellations. Nevertheless, the ongoing megaconstellation race has piqued interest from other contenders, particularly from US Big Tech companies, making it possible for another megaconstellation to enter the market. Additionally, we take a cautious approach regarding the Chinese sovereign constellation, projecting a maximum of 500 operational satellites by 2030. We also exclude early-stage projects, such as Grey Wyler's E-Space, which aims to launch a staggering 300,000 satellites for its sustainable constellation endeavor.

FIG 13: NUMBER OF OPERATIONAL SATELLITES 2000-2030E

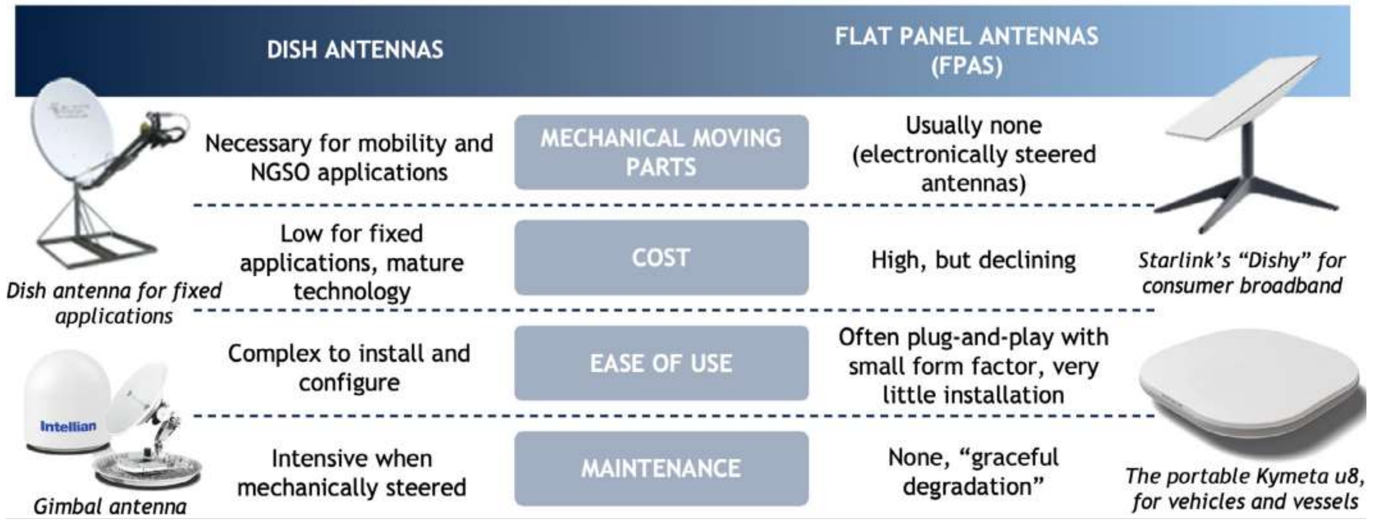


Source: Stifel estimates*

Ground matters too

Constellations have unleashed a profound impact by enabling revolutionary business models, yet the adoption of LEO also brings its unique set of challenges. Notably, the ground and user segments have often proven to be the Achilles' heel of megaconstellations, while the space segment is well-mastered. The complexity of antennas for LEO satellites surpasses that of GEO counterparts, as LEO spacecraft continuously traverse the sky, demanding antennas capable of swiftly tracking multiple satellites in motion above. Traditional parabolic dish antennas struggle to accomplish this effectively without relying on relatively inefficient mechanical components. Electronically steered antennas (ESA) have emerged as a promising albeit expensive solution for user terminals, offering a sleek Flat Panel Antenna (FPA) form factor. However, the cost reduction for FPAs has been slower than expected, limiting its adoption beyond military markets where terminal capabilities outweigh expenditure concerns. SpaceX has successfully deployed over a million FPAs to cater to its Starlink clientele. However, the production cost, which is rumoured to be significantly higher than the USD599 charged to customers, has emerged as a vulnerability in the economics of the constellation.

FIG 14: THE TECHNOLOGICAL SHIFT TOWARD ELECTRONICALLY STEERED FLAT PANEL ANTENNAS (FPAS)



*Source: Stifel**

FIG 15: MAPPING OF ANTENNA COMPANIES DEVELOPING FPAS

Specialised players

KYMETA, Intellian, Greenerwave., ThinKom, ALL.SPACE, SatixFy, Ball, Hanwha systems, alcan, Gilat

Integrated operators

amazon, INTELSAT, STARLINK, VIASAT

*Source: Stifel**

The market for ground stations has also experienced significant shifts. Traditionally, ground stations were primarily designed to communicate with geostationary satellites in higher orbits. However, with the rise of NewSpace players and the deployment of LEO constellations, the demand for ground stations has expanded and diversified. When Planet and Spire began deploying large constellations of cubesats in the mid-2010s, they had little choice but to also deploy sprawling, proprietary ground station networks across the Earth to retrieve their data from space. But companies have emerged, specialising in the design and construction of ground stations specifically tailored to serve LEO constellations. Now, several companies offer «ground-as-a-service» to smallsat operators, providing a means to outsource ground communications.

As new satellite operators enter the scene, many lack the experience, capital, or inclination to invest in their own ground segment, especially when operating satellites in LEO necessitates a global network of ground stations across multiple countries. Consequently, many of these satellite operators are turning to ground segment services that provide flexibility and efficiency, eliminating the need for substantial upfront investments or helping to deal with licensing.

The space industry's adoption of cloud data storage has accelerated the outsourcing of ground communications services since satellite data can be downlinked directly to the cloud. Amazon Web Services (AWS) has already emerged as a prominent provider of cloud-computing services to the space industry, operating nearly a dozen ground stations across its global data centres. Microsoft, on the other hand, has formed a partnership with SES to establish cloud infrastructure, while Google has joined forces with SpaceX, that will install ground stations within Google's data centres for its broadband satellites.

Addressing the growing capacity requirements for space-to-ground links is another crucial challenge faced by ground stations. Possible solutions involve transitioning to higher RF frequency bands, or adopting optical ground stations that use innovative laser technologies, such as those currently being developed by the French start-up, Cailabs.

FIG 16: MAPPING OF GROUND STATION PLAYERS

*Source: Stifel**

2.2 THE SATELLITE **BROADBAND OPPORTUNITY**

Commoditisation of available satellite bandwidth

The satellite communication market, valued at USD 30bn in 2022, stands as a cornerstone of the commercial space economy. Operators have suffered from anaemic growth and erosion of broadcast revenue in recent years, due to the increasing popularity of over-the-top (OTT) media and non-linear viewing habits that have reduced the usage of satellite TV. However, a turning point in growth is expected, as the increasing demand for broadband services is anticipated to more than offset the secular decline in broadcast. Satcom markets are now set to grow at 10-12% CAGR this decade driven by booming connectivity segments.

Telecommunication satellites have indeed undergone a quiet revolution over the past 15 years, radically reshaping their performance and economics for broadband connectivity. Core to this change is the advent of high-throughput satellites (HTS), a new class of satellite that uses spot beams to massively improve capacity.

Is Moore's Law striking the satellite industry? The development of the HTS in 2005 was accompanied by a 10x improvement in capex efficiency (required capex to deploy one unit of capacity), which then continued to approximately halve every five years. HTS systems currently coming to the market are 100x more capex efficient than traditional wide-beam satellites. Satellite connectivity remains expensive but is narrowing the gap in terms of price and quality with high-speed terrestrial networks. And in some cases, satellite remains the only cost-effective way to deliver connectivity. Improved satellite economics with ever lower break-even points for HTS systems should seduce more users.

Operators are thus deploying huge amounts of capacity as abundant broadband should unlock demand across many verticals - an opportunity for TV-exposed incumbents to find growth relays. The current deployment cycle should however be dominated by the emergence of LEO megaconstellations, which should soon account for most of capacity supply. We expect global HTS capacity supply to grow >10x between 2020 and 2026, topping about 50Tpbs of sellable capacity in 2026. NGSO should make up 80% of additional capacity, a marked contrast to the historically dominant share of supply held by GEO-HTS systems.

FIG 17: SELLABLE BROADBAND SATELLITE CAPACITY SUPPLY TO GROW BY 9X BY 2026

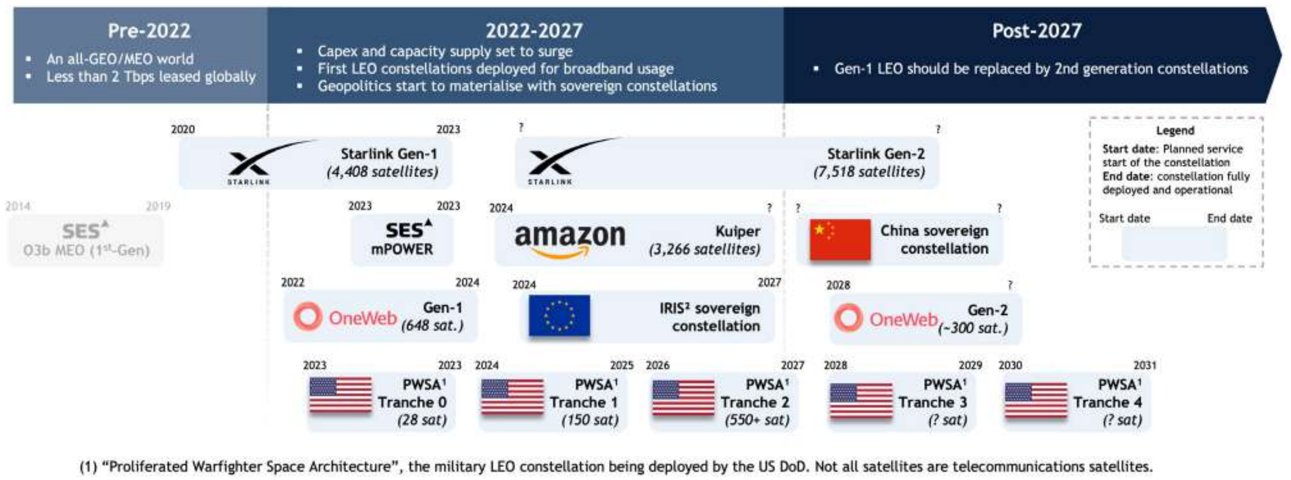
Source: Stifel estimates. NGSO constellations are adjusted to accommodate capacity that can be effectively sold, which we estimate to be approximately 30% of gross capacity for LEO and 70% for MEO.*

The multi-orbital future of satcoms

The utilisation of closer-to-Earth orbits represents one of the most revolutionary trends in the satcoms industry today, propelled predominantly by Starlink, and is poised to reshuffle the cards between established players and deep-pocketed new entrants. LEO satellites are closer to Earth than GEO satellites, which allows significantly lower latency on par with terrestrial connections. But ensuring continuous coverage necessitates hundreds of satellites, resulting in a much more complex global system, and often much bigger in terms of capacity and capex envelope. The advent of LEO gained momentum in broadband applications during the mid-2010s with OneWeb, led by O3b's founder Greg Wyler and then backed by Google. OneWeb is currently deploying its constellation, but the service is not yet fully operational. Since then, numerous other LEO constellations have been announced, including SpaceX's Starlink and Amazon's Kuiper, with cape plans that far surpass previous industry benchmarks.

In the late 2010s, scepticism dominated the industry's discourse regarding LEO broadband constellations and the scale of the market demand for their services. A widespread idea was that at best one or two constellations would survive. However, over the past 12-24 months, confidence in the success of most LEO deployments has soared, owing to several key factors. Firstly, these projects have secured substantial funding, most notably with the entry of Amazon and its USD10bn constellation plan, and SpaceX's ability to raise capital at a USD100bn valuation. Secondly, the operational success of Starlink has unequivocally proven the viability of the technology, even in military theatres. Lastly, the progressive adoption of the LEO architecture by the US Department of Defense has amplified the military significance of megaconstellations. We now see at least five LEO megaconstellations succeed in their operational deployment by 2027: Starlink, Amazon Kuiper, OneWeb, and the sovereign constellation from the US and the EU.

FIG 18: MAIN BROADBAND CONSTELLATION DEPLOYMENTS ANNOUNCED



Source: Stifel. (1) «Proliferated Warfighter Space Architecture", the military LEO constellation being deployed by the US DoD. Not all satellites are telecommunications satellites.*

LEOs could quickly become more cost-efficient than GEOs

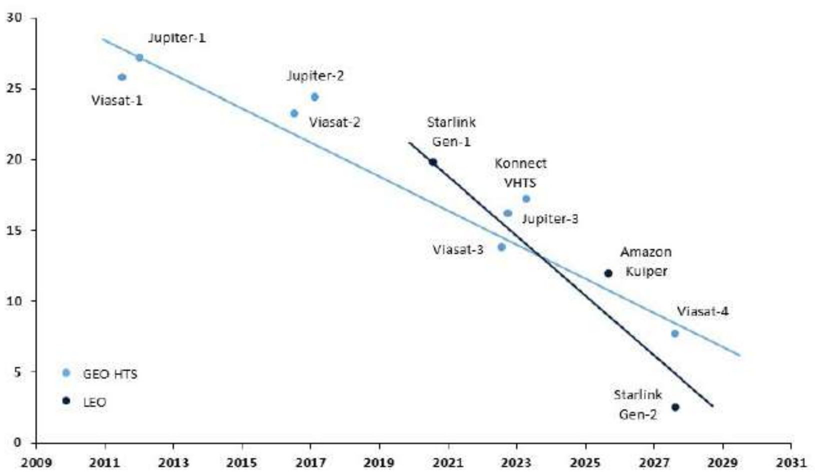
We have conducted a cost-per- sellable-Mbps analysis of the next generations of LEOs and GEO-VHTS. We see a significant risk of GEOs losing their lower cost advantage to Gen-2 LEOs, which can take advantage of economies of scale to reduce costs at a faster rate than traditional HTS GEO satellites. Although many uncertainties remain, we believe that LEOs have significant chances of becoming generally cheaper than GEOs post-2027, when Gen-2 constellations will be deployed.

Although we see LEOs to remain sub-cost-of-capital return investment until at least Gen-2 constellations, we believe incumbents will have no choice other than moving into LEO which will require massive investment, or they will see growth opportunities be absorbed by new entrants. Among LEOs operators, we believe intensifying competition could lead to quick deployment of LEO Gen-2 constellations. Both Starlink and OneWeb now have plans for a Gen-2, and the first to deploy will benefit from more capacity at lower cost-per-Mbps. We believe SpaceX sees Amazon Kuiper (expected to be operational by 2026) as its primary rival, meaning Starlink must move quickly to deploy its Gen-2 system and maintain its competitive edge.

Several players, such as Eutelsat and SES, are betting on a shift away from a single architecture-defined future ('LEO vs GEO') and toward a multi-orbit future. The promise of multi-orbit services is to combine the advantage of each orbit: using GEO for capacity complementation in high-demand areas, by routing latency sensitive traffic to LEO while latency independent traffic is routed to GEO. SpaceX's comments so far are that multi-orbit solutions add too much complexity to the system. We believe SpaceX is however likely to increasingly open its network to distributors and potentially equipment manufacturers.

Many manufacturers and operators are aiming to bring more flexible and interoperable antennas to the market medium-term. The US DoD is also pushing for integrated multi-orbit, multi-band services. Several antenna companies (such as All.Space, Kymeta and Intelsat) have successfully tested military-grade terminals enabling interoperability between different orbits and operators. Today, such military-grade equipment is costly, but the US DoD can afford expensive terminals. Cost reduction to consumer-grade levels appears realistic in the medium term, while uncertain. The end game could be terminals usable in multiple orbits and at multiple frequencies, so operators could deliver services with the best of both worlds among all orbit's trade-offs. Customers are also pushing for adaptive terminals, to avoid ending up captive to one constellation that could be discontinued.

FIG 19: EVOLUTION OF COST PER BIT: GEO HTS VS LEO (IN CAPEX PER SELLABLE MBPS PER MONTH, LOG SCALE)



Source: Stifel.*

Satellites are entering the age of software-defined

As part of a broader digitalisation of the telecoms industry, satcom is transitioning to virtualised and software-defined networks. Traditional satellites were programmed for a specific mission and cannot be modified during their lifespan, a significant market risk.

Software-defined satellites (SDS) are characterised by payloads that can be reconfigured in orbit thanks to on-board processors that can be re-configured from the ground. SDS payloads notably contain:

- Beamforming Antennas providing the satellite with adaptable beam footprints for mission changes, i.e. to modify coverage areas dynamically in orbit with steerable or shapable beams.
- Digitisation and on-board processing capabilities: allow dynamic allocation thanks to routing or channelization.

Software-defined satellites provide a more flexible and cost-effective approach to network upgrades, enabling operators to quickly and easily implement changes and improvements as needed. SDS can change coverage areas, power allocation and potentially even frequency bands on-demand and at any point in the satellite lifetime. As such, no capacity is wasted on services that are not demanded by end users – allowing to improve fill rate and limit obsolescence. The pace and scale of GEO SDS have increased exponentially in recent years, after LEO smallsats (usually SDS for technical reasons) have paved the way. SDS have accounted for 65% of GEO orders in 2021 as main satellite manufacturers developed successful SDS product lines, e.g. Airbus (OneSat) and Thales Alenia Space (Space Inspired). Adoption of digitalised, flexible satcom networks (space and ground segments) is becoming a key requirement of the US DoD, which in our view will drive further adoption and innovation.

FIG 20: SOFTWARE-DEFINED VS TRADITIONAL BENT PIPE ARCHITECTURE

BENT PIPE ARCHITECTURE		FLEXIBLE SATELLITES AND GROUND NETWORK
At the manufacturing stage	CUSTOMIZATION	Standardized hardware, customization shifted to software
Lower	COST PER BIT	Higher, but standardized production may drive manufacturing costs down
None	RECONFIGURABILITY	Depending on level of flexibility, footprint and spectral power can be reconfigured in real time
None to little flexibility (mechanical steering)	BEAMS	Steerable and/or shapable beams

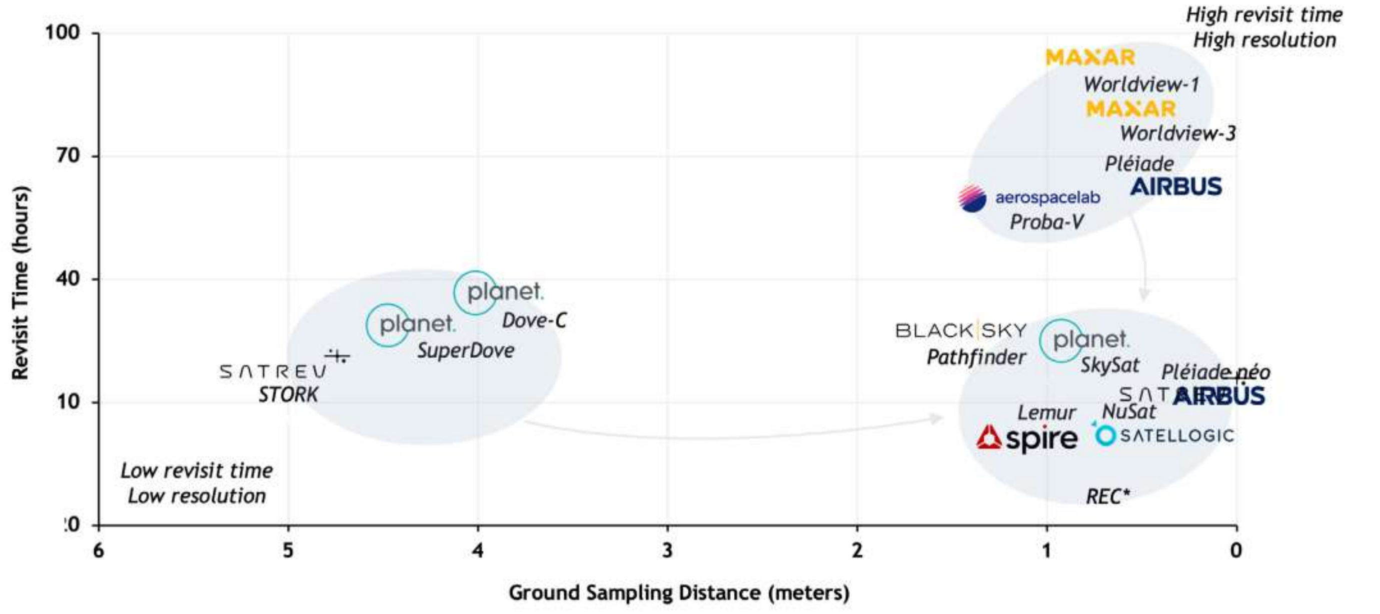
*Source: Stifel**

2.3 THE RAPID GROWTH OF **EARTH OBSERVATION**

Newspace ventures are eyeing Earth Observation

Constellations' ability to provide continuous coverage of the Earth's surface has disrupted the field of Earth Observation as well. The industry is moving forward in two parallel ways, seeking to enhance image precision, while at the same time lowering revisit time and increasing availability of imagery. As large constellations ensure that there is always at least one satellite in position to capture images of a particular area, they offer an attractive alternative to traditional EO satellite systems relying on a small number of large, expensive, and non-ubiquitous satellites.

FIG 21: NEW SPACE SATELLITES COMPENSATE HIGH GROUND SAMPLING DISTANCE (GSD) WITH LOWER REVISIT TIMES

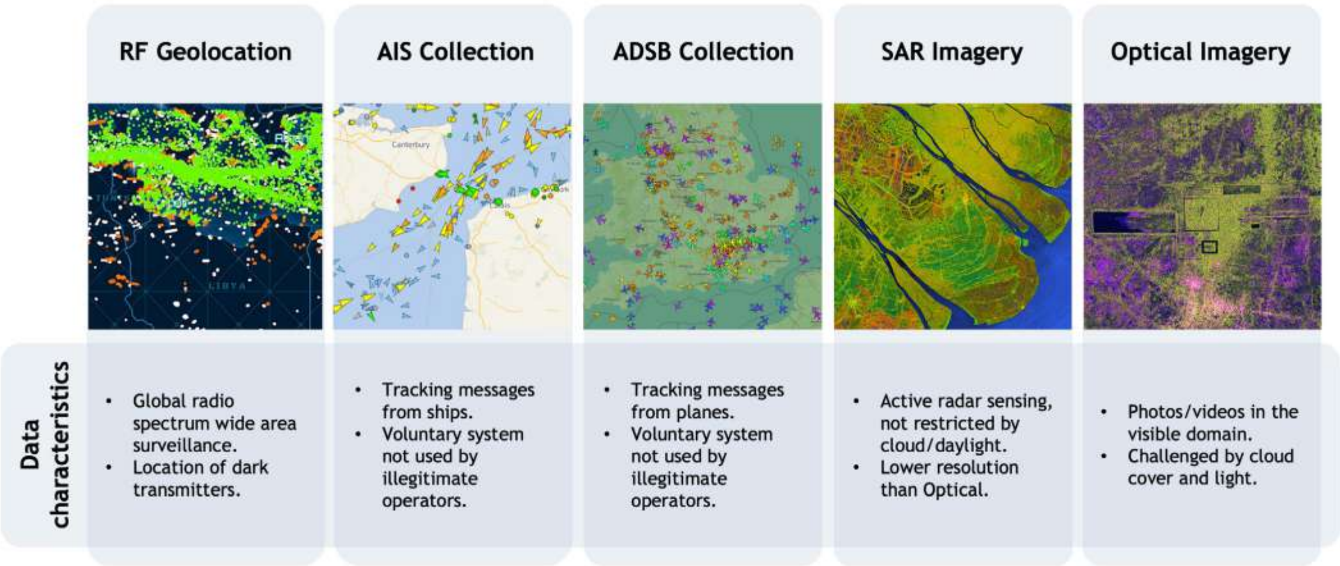


*Source: Stifel**

To achieve a desired revisit time, satellite operators can adjust the orbital parameters of the satellite, such as the altitude, inclination, and eccentricity of the orbit. They also adjust the constellation design, to place multiple satellites in orbit and provide more frequent coverage of a particular area – thus increasing the acquisition capacity.

In some cases, alternative technologies such as synthetic aperture radar (SAR) can be used to provide complementary coverage and improve revisit time. Unlike optical imaging systems, SAR can operate day or night, in all weather conditions, and can penetrate clouds, smoke, and other obstacles that limit visibility. In a SAR system, the radar antenna emits pulses of electromagnetic radiation, the signals bounce off the Earth's surface and are then detected by the same antenna or a separate receiving antenna. By measuring the time delay and phase shift of the returned signals, SAR can generate a two-dimensional image of the Earth's surface.

FIG 22: THE VARIETY OF EARTH OBSERVATION TECHNOLOGIES INCREASES ACQUISITION CAPACITY AND REVISIT TIME



Source: Stifel, Kleos Space Presentation*

As the demand for Earth observation data keeps increasing, we have witnessed a surge in investment in Earth observation constellations, with many companies, such as Planet, BlackSky, and Spire, launching large constellations of small satellites over the past few years. These constellations are likely to gain importance, providing a valuable source of data for a wide range of applications.

As innovative new players can offer missions focusing on revisit of specific areas or assets and provide data at a very low price thanks to the development of a low-cost infrastructure, they appeal to new types of customers and create an open field for innovation – leading to the explosion of EO data and projects.

If Earth Observation satellites were traditionally owned and/or operated by public organizations, since 2009 we observe a major change of paradigm with the emergence of new players, exclusively funded by private money. That is not to say that public institutions have exited or lost interest in satellite imagery – rather the contrary. But rather the shift comes from the permeability of the two sectors and the increased purchase of private data by public actors – facilitated by more flexible policies. As evidence, in December 2022 the US Government Accountability Office (GAO) reported that NASA had the largest amount of commercial satellite imagery spending for the US with a total of USD75,6m spent since 2018.

Through partnerships and information-sharing, public and private sectors leverage their respective resources to deploy innovative technologies and applications for monitoring our planet thus accelerating scientific progress but also unlocking new economic opportunities and social benefits, such as improved disaster response, environmental management, and agricultural productivity.

New opportunities for satellite data analytics

The world is currently witnessing the parallel explosion of data analytics technologies and Earth observation technologies. Data analytics technologies have been driven by advancements in artificial intelligence and machine learning. Combined with continued improvements in computing power and global IT infrastructure, this has greatly enhanced the opportunities for data analytics providers. In parallel, Earth observation technologies have advanced rapidly in recent years and have been driven by the development of new low-cost small satellites constellations.

Earth Observation analytics platforms are a new paradigm, leveraging the combined power of data analytics and Earth observation technologies. Earth Observation «only» observe parts of the planet while Earth Observation analytics platforms build value upon data collected by satellites imagery providers through the development of predictive software and surveillance platforms. It is about using and fusioning all data available on given assets (satellites, drones, geolocation, tweets, web, sensors/IoT...) to provide reliable, frequent, accurate, georeferenced and time-stamped information on the status of the selected physical assets.

The value chain of Earth Observation analytics breaks down into three major categories of participants:

- At the top of the value chain stands the satellite imagery provider: satellite and other aerial imagery, mobile operator, IoT sensors, public data from the web and social networks.… In the case of Earth Observation data, the data provider operates constellations providing various types of images such as optical or radar. These can be public organisations such as the European Space Agency's Sentinel constellation providing images for free, or private companies such as the US-based Planet.

- At the other end of the value chain stand the end users: corporations, governments, and non-governmental organisations. Through data analytics software using EO data, they seek to either 1/ increase the productivity of their operations or investments, 2/ better manage pricing volatility on their markets, 3/ enhance the monitoring and control of their own or third-party business activities or 4/ address sustainability considerations.

- In the middle stand the Earth Observation analytics platforms, which create value-added data and provide advanced data analytics services from the processing of raw satellite imagery in conjunction with other sources.

FIG 23: EARTH OBSERVATION ANALYTICS PLATFORMS BUILD VALUE UPON DATA COLLECTED BY SATELLITES IMAGERY PROVIDERS THROUGH THE DEVELOPMENT OF PREDICTIVE SOFTWARE AND SURVEILLANCE PLATFORMS

*Source: Stifel**

Earth observation analytics involves many stakeholders and applies to a large number of use cases

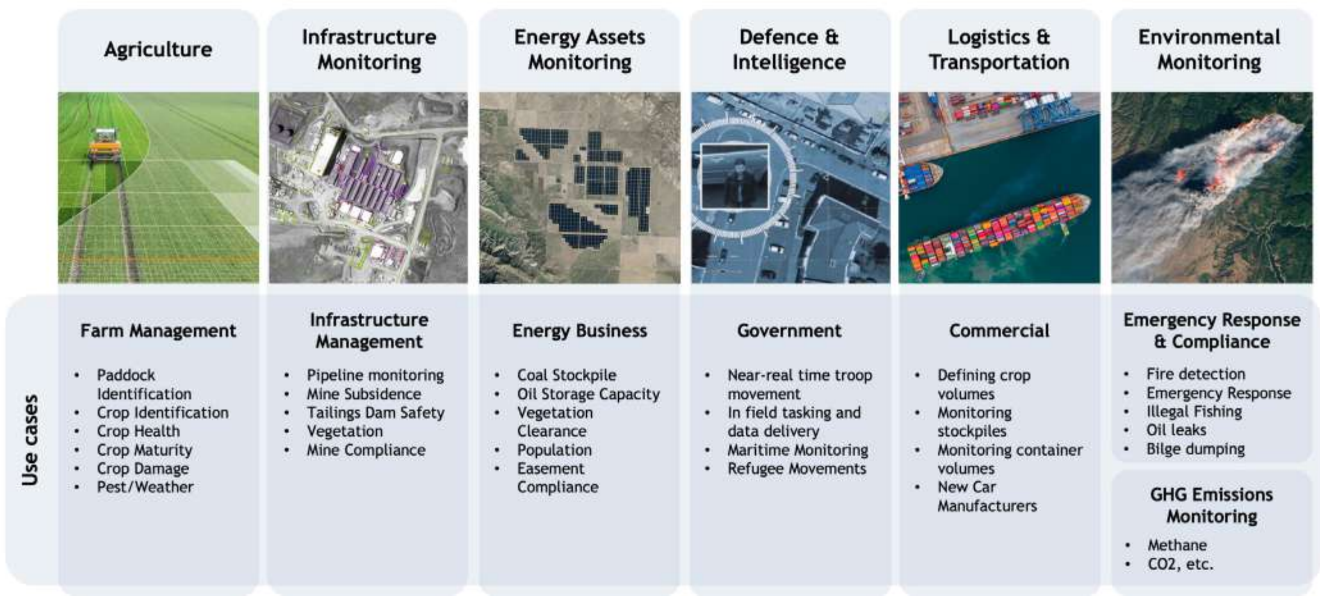
As information is proving an essential factor of competitiveness in today's global economy, the demand for more accurate and comprehensive access to data, related analytics and insights is rising. Over time, the available sources of valuable data have been multiplying, from proprietary information systems (CRM, ERP…) to public information and alternative sources such as web, social networks and IoT sensors. For data analytics providers, value is moving towards the ability to aggregate and provide insights on multiple sources of data in what is called data fusion.

This democratised access to precise EO data combined with progress in data analytics technologies has laid the foundation for a multitude of Earth Observation analytics platforms to emerge. Notably, Euroconsult estimates the value of the 1-metre ground resolution imaging market will gradually decrease over time, making the market for data in the 50 cm and below range the first by revenue by 2027 (growing at a 17% CAGR throughout the decade).

Earth Observation analytics are substantially impacting the way businesses operate, as they drastically improve the ability to measure activities on any specific asset and enables anyone impacted by the status of that asset to take better decisions.

A number of different stakeholders can see the clear value proposition in gaining quicker and ubiquitous access to accurate information from the use of Earth Observation data analytics. These include asset owners, investors, suppliers and customers, traders, risk managers, regulators and other public authorities. As a result, the last decade has witnessed the emergence of new use cases for Earth Observation data analytics ranging from legacy fields such as Defence & Intelligence to emerging issues such as Environmental monitoring.

FIG 24: MANY USE CASES CAN BE IDENTIFIED, WHICH CAN BE BROKEN DOWN INTO SIX MAIN CATEGORIES

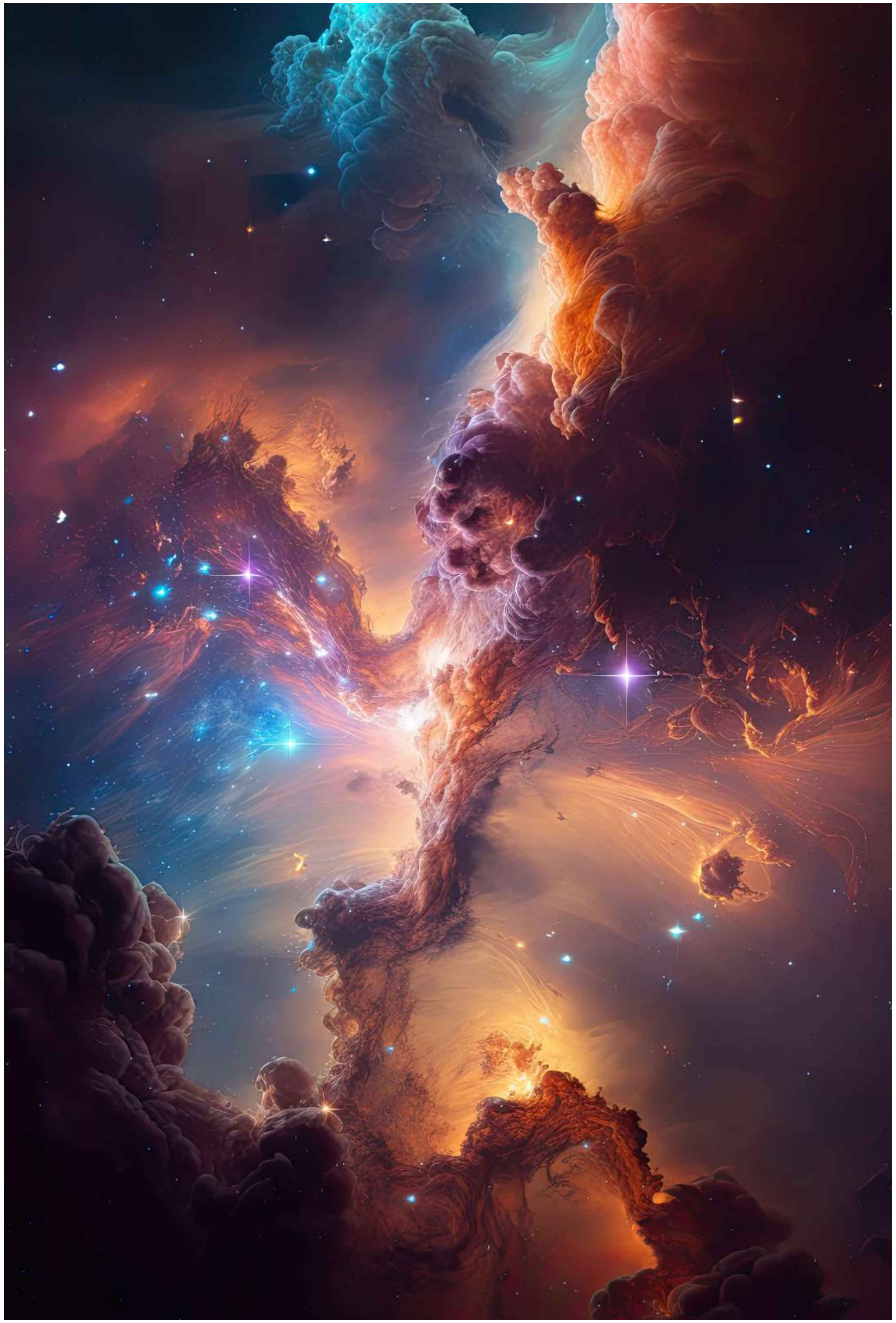


*Source: Stifel**

COMPANY FOCUS

ICEYE

Iceye, having successfully secured over EUR250 million in funding, stands out as one of Europe's premier Earth Observation companies. The company is operating a constellation of satellites providing SAR (Synthetic Aperture Radar) imagery. It has launched 25 satellites since 2018. In a strategic departure from many Earth Observation competitors who rely on optical systems, Iceye has committed to Radar technology from the start (it has recently announced the introduction of optical capabilities thanks to a strategic partnership with Satlantis). Radar imaging empowers the company to surveil Earth's surface through cloud cover and in the darkest of conditions, both day and night. Iceye's distinctive approach extends to its fully integrated business model, where all technology is crafted in-house, resulting in the issuance of dozens of patents. Notably, the company has pioneered its proprietary technology featuring active beam control with electronic steering capabilities. With a product portfolio encompassing SAR data and Satellite systems, Iceye serves a diverse clientele spanning government and commercial sectors, with a particular emphasis on insurance, especially in the context of environmental and natural catastrophe monitoring. The group's technology equips Iceye's customers with the ability to make data-driven decisions in near real-time, enhancing their situational awareness with the ultimate goal of improving response and recovery efforts.



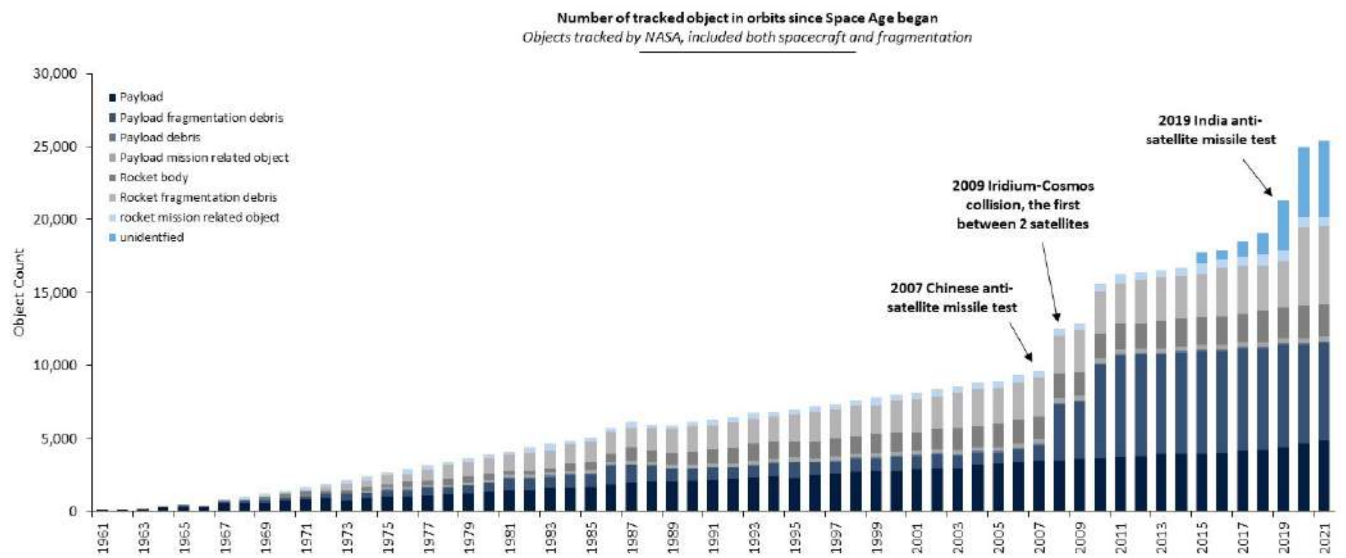
ADDRESSING SPACE **SUSTAINABILITY** AND **SECURITY ISSUES**

SECTION 3

Sustainability and security are growing concerns for the space industry. The accumulation of space debris can generate collisions, and possibly cascade effects that could render some orbital regions unusable for decades, if not centuries. As more countries and commercial entities are investing in space, concerns are mounting related to cyber-attacks on space systems, the militarisation of space, and the possibility of intentional physical attacks on satellites. Cybersecurity and in-orbit services markets are emerging as fast-growth opportunities, ensuring the security and integrity of critical space infrastructure.

3.1 **SPACE SECURITY** AND **SUSTAINABILITY** THREATS ARE GROWING

FIG 25: THE GROWING PROBLEM OF DEBRIS



*Source: National geographic, Stifel**

Space Sustainability: the growing problem of debris

Space debris is one of the most significant safety hazards for satellites. In 2016, a particle of debris as tiny as 0.1mm, possibly a flake of paint, produced a 7-mm fissure in a quadruple-glazed window of the ISS. Most spacecrafts thus have shields to protect them from small debris, but solar panels wear from repeated low-mass impacts. Larger debris pose a serious threat and hundreds of collision-avoidance manoeuvres are performed every year. The first major satellite collision occurred in 2009 between a derelict Russian satellite and an Iridium satellite, resulting in the destruction of both spacecraft and large amounts of debris.

The amount of space debris keeps growing. Adding to the congestion in space and debris from collisions, is all the debris from defunct satellites and rockets - and it takes a significant amount of time for debris to fall back to Earth. Satellites orbiting at an altitude of 500km, like those of Starlink, usually re-enter the Earth's atmosphere after approximately 25 years and disintegrate rapidly upon entry. The time required for debris to re-enter the Earth's atmosphere grows exponentially with altitude, ranging from approximately 100-150 years at 800km to an indefinite period in GEO.

Of particular concern is the Kessler Effect, whereby the total amount of space debris will keep on increasing once past a certain critical mass: collisions give rise to more debris and lead to more collisions, in a chain reaction. Space could then become inaccessible for decades or much longer.

In the past decade, the main concern has been the potential consequences of a «space war", after the amount of space debris increased sharply following three anti-satellite weapons (ASAT) tests performed by China, India and Russia. The debate is however shifting to the general proliferation of low-cost satellites, pointing to enhanced collision risk of satellites with few backup systems and unproven traffic management capability.

Today, there are no international regulations to curb the number of satellites a private company can launch or to limit which orbits they can occupy. Megaconstellations have come under heavy criticism, as they are granted permission to launch tens of thousands more satellites. We believe there will be a need to impose stricter standards to regulate access to space for large-scale commercial projects. In September of last year, the Federal Communications Commission (FCC) approved a rule to address growing debris in LEO, mandating that LEO spacecraft must be deorbited as soon as possible, and no later than five years after the completion of their missions. Nevertheless, the question of whether the FCC possesses the authority to regulate space in such a manner, as well as whether any existing regulatory body holds global jurisdiction over space regulation, remains unresolved. And so far, the speed of commercial development is much faster than the speed of regulation change.

The sustainability of the space environment is thus emerging as a paramount concern for institutional space programs, faced with mounting pressure to tackle the issue of space debris in crowded orbits. In recent years, States have expressed their willingness to act on the matter either through legal means by prohibiting or regulating the creation of debris, or through technological means such as in-orbit operations and debris tracking. The European Space Agency (ESA), for example, recently inked a contract worth EUR86m with Swiss NewSpace start-up ClearSpace to launch a space debris removal mission in 2025. The mission will utilise an experimental, four-armed robot to capture a 100kg debris, left behind by a Vega launcher in 2013, located about 800 kilometres above Earth.

The reality of space as a warfighting domain

Space is a harsh environment for satellites due to radiations, micrometeoroids, debris, and extreme temperature… but also human-made hazards. Space remains a crucial military theatre, particularly for the United States, and an increasingly assertive China. Military space assets like satellites and ground systems typically have been considered «support» equipment that provide valuable services such as communications, navigation data and early warning of missile launches. As the Pentagon has grown increasingly dependent on space, satellites are becoming strategic assets and coveted targets for adversaries. There is an increasing concern over intentional attacks on satellites, which could result in severe consequences.

The establishment of the Space Force as a new branch of the US military in 2019 was a surprise to many in the space community and beyond. It marked a significant shift in the country's approach to space, recognising the growing importance of space operations for national security and defence in the 21st century. FY24 budget request for the US Defence Department now includes USD30bn for the Space Force, almost 4% of the total US military budget.

There have been reports of countries developing various space-based capabilities that could be used for military purposes. These include anti-satellite weapons (ASATs) designed to disable or destroy satellites, as well as ground-based lasers and directed energy weapons that could be used to blind or damage satellites in orbit. Four countries have successfully used destructive ASAT weapons — Russia, China, the US, and India. The notion of co-orbital ASATs has captured interest as a potential new dimension of space conflicts. A rudimentary version of this concept involves «killer satellites» that are designed to physically collide with and eliminate enemy satellites. However, co-orbital weapons could evolve into more sophisticated forms, capitalising on advancements in robotics and employing direct weaponry like lasers or corrosive agents to impair critical components of enemy satellites.

As satellites play an increasingly critical role in modern economies and national security, commercial satellites have also become targets for cyber and physical attacks. Malicious actors can intentionally damage or disable satellites through electronic or kinetic means, disrupting critical services such as navigation, communication, and intelligence gathering. With the reliance on space-based assets across critical civilian and defence domains, it has become imperative to implement more robust measures ensuring the safety and security of these invaluable resources.

The concerns related to the weaponisation of outer space are fueling an institutional demand for innovative space services, including cybersecurity and in-orbit capabilities. Adversary spacecraft could potentially damage space systems, necessitating maintenance and repair operations to maintain their operational readiness. Moreover, intentional collisions between space objects could escalate the demand for debris de-orbiting services.

FIG 26: A BROADENING RANGE OF ASAT WEAPONS

*Source: Stifel**

3.2 CYBERSECURITY OF SPACE SYSTEMS

The new vulnerabilities of satellites

New technologies are giving rise to new types of threats for satellites, despite the growing importance of the space-based services they provide to modern economies and geopolitics. And because they are in orbit doesn't mean satellites are out of reach of attack. Indeed, as US National Cyber Director Kemba Walden puts it: defending space systems against cyberthreats remains „urgent and requires high-level attention". In line with this, the White House hosted its first space industry cybersecurity workshop in late April this year in southern California.

Increasingly sophisticated threats such as electronic warfare and cyberattacks are now tangible and harmful options for attackers. As highlighted in the previous section, in search for higher agility and lower costs, NewSpace is increasingly „software-based", and while legacy space was based on expensive proprietary technologies, NewSpace technologies are relying on more common hardware and software components, opening up „terrestrial-like" IT vulnerabilities.

In this context, cyber-attacks on space assets are not only a growing threat, they have become reality. The best illustration is Russia's deliberate cyber-attack on ViaSat's KA-SAT network in February 2022. Unprepared for such an attack, ViaSat saw its modems being affected all across Europe. Starlink satellites also underwent jamming attempts from Russia in the beginning of the Ukrainian war in 2022, but thanks to the company's ability to update satellite software within a few hours, Starlink was able to prevent the constellation from going down.

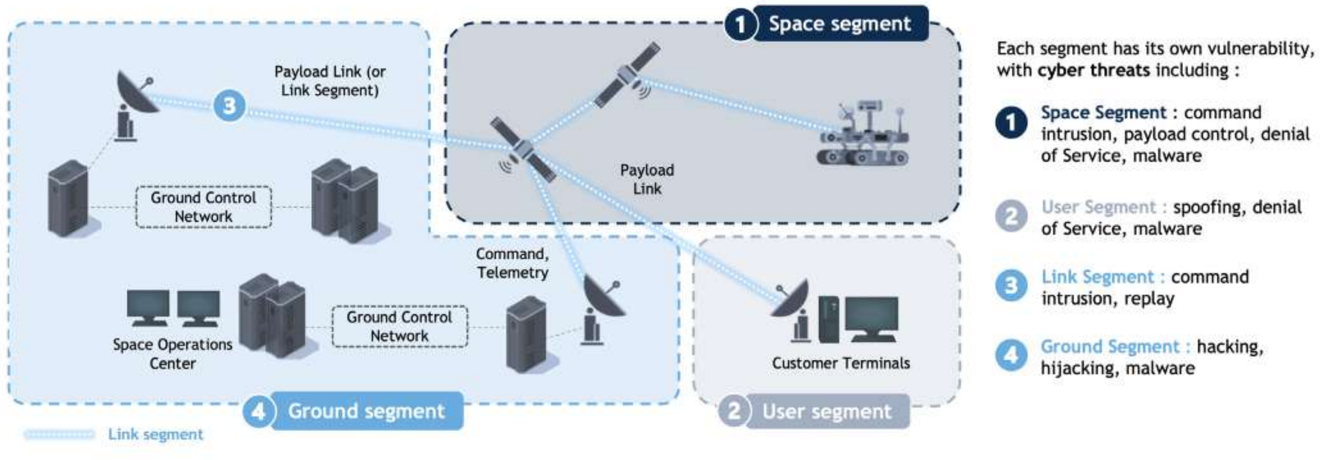
Recently the press reported that, according to a leaked US intelligence report, China was building sophisticated cyber weapons to «seize control" of enemy satellites, rendering them useless for data signals or surveillance during wartime.

Indeed, space systems have become increasingly interconnected and computationally complex and as such, vulnerable. A space/satellite system is made of several segments, each of which has its own vulnerabilities:

- The Space Segment, which includes space aircrafts
- The Link segment, where the signal is transmitted, uplink and downlink, between the satellites and the ground segment or the user segment
- The Ground segment, including the teleport and the ground control network
- The User segment, which is made of the customer terminals

Besides disruption to internet services (which can be critical in conflictual context such as in Ukraine), loss of connectivity can disable remotely controlled systems, loss of positioning signals can disrupt air transport, road traffic and shipping, while interference with satellite imagery services can compromise military intelligence and invalidate scientific studies by altering their source data. SSA data could also be targeted, artificially altering debris collision forecasts and causing direct harm to critical space systems. All of this can be achieved without firing a single rocket.

FIG 27: THE DIFFERENT VULNERABILITIES OF SPACE SYSTEMS TO CYBER THREATS



*Source: Stifel**

The changing paradigm of space cybersecurity

The challenge is thus to ensure end to end protection of highly complex Space Systems that are distributed by nature, combining on premise (user segment), cloud (ground segment) and edge (space segment) computing environments.

Historically however, space industry players have relied heavily on proprietary environments, focusing on hardware to the detriment of software expertise. If they want to remain competitive and agile, they need to adapt to a changing paradigm in the industry. Space systems architecture must be adapted in order to outpace adversary threat: new state of the art technology will involve open standards, increased modularity and decoupling of hardware and software using abstraction and containerization.

Even large organisations (governmental agencies, large satellite manufacturers) cannot afford to stick to traditional proprietary software and hardware architectures, risking of lagging behind competitors. They need to move from a siloed approach to a «zero trust» architecture. All space players are to be impacted: satellite operators and distributors (commercial and governmental constellations), ground segment operators, satellite manufacturers, SSA and in orbit services providers, but also launchers as well as all other players involved in the design, manufacturing and operations of space aircraft.

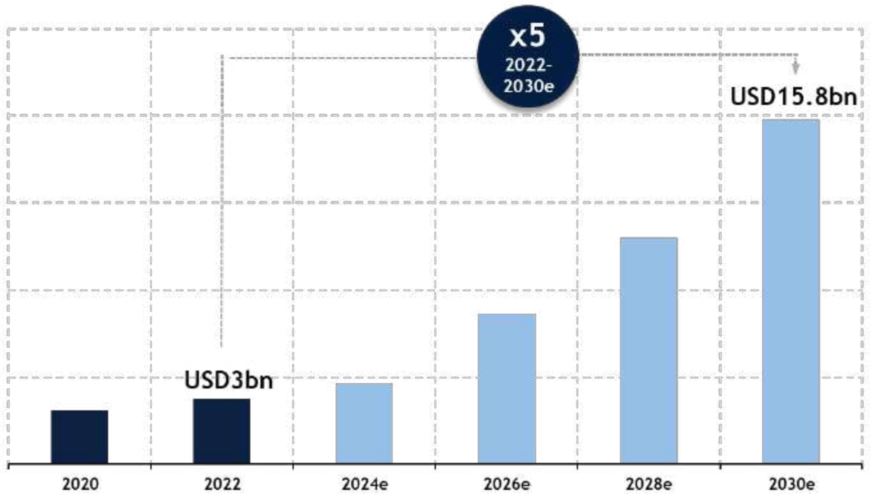
This is not only about technology, but also a major cultural change - a challenge for legacy players, and an opportunity for newcomers. Cybersecurity concerns must be integrated at each stage, from design to operations, alongside new software development approaches such as DevSecOps, to ensure a reduced innovation cycle and higher reliability of systems.

Space cybersecurity encompasses many dimensions as in the terrestrial world, which includes i/ Risk and Threat evaluation, ii/Protection and iii/ Detection and Response. There are significant opportunities laying ahead for IT services specialists with specific expertise in the space sector as well as for advanced technology providers in multiple domains such as network security (encryptors, diodes and gateways, software or hardware VPNs…), cryptographic key management (generation and distribution of keys, online or offline); hardened/secure OS for the protection of embedded systems, applications and data (such as PikeOS by Sysgo/Thales, or Arca by Cysec); authentication services; sensors/probes (for the monitoring of systems and threat detection).

23% CAGR opportunity by 2030

Addressing concerns will require all players in the space sector to spend an increasing share of the budget on cybersecurity services and products. We are still in very early stages, cybersecurity concerns have been overlooked for quite some time, space incumbents and even some smaller younger players lack maturity in the software world, but we expect the space cybersecurity market to accelerate sharply in the coming years. We expect the market to rise by a factor of 5x between 2022 and 2030, i.e. delivering a 23% CAGR over the period.

FIG 28: OUR FORECASTS FOR THE SPACE CYBERSECURITY MARKET



*Source: Stifel**

A number of companies are active in the delivery of space cybersecurity products and services. They include major legacy space players, more focused on large scale and governmental programs, as well as IT Services firms and smaller innovative players such as Cysec, Spideroak or Spacebelt, riding on massive opportunities from the development of commercial applications in particular.

FIG 29: MAPPING OF SPACE CYBERSECURITY PLAYERS

*Source: Stifel**

Quantum key distribution

Satellite-based quantum key distribution (QKD) is an attractive sub segment of space cybersecurity, although it should remain a niche in the governmental segment. With the rise of quantum computing, traditional encryption protocols and technologies could no longer be safe. Quantum-based cryptography addresses the threat, but current technologies are facing distance-related constraints (signal attenuation on optical fibre) limiting the reach of key distribution. Using satellites to manage quantum key distribution helps remove the issue.

Although space-based QKD is being challenged by works on post-quantum cryptography and alternative terrestrial technologies can also be considered (such as quantum repeaters whose technology is far from being mature, due to the no-cloning theorem in quantum physics), the technology is becoming strategic: The European program Eagle-1 (a partnership between ESA and a consortium of 20 European companies led by SES), due to launch in 2024, aims to demonstrate the feasibility of quantum key distribution from low Earth orbit to the ground. Europe appears three-thirds years behind China in the field, however. Indeed, China demonstrated last year the distribution of an (entanglement-based) quantum key using its Micius satellite, and Chinese research institutes are working to construct a quantum communications network using satellites in low and medium-to-high Earth orbits.

FIG 30: MAPPING OF QKD PLAYERS

TESAT | ARQIT | IDQ | KETS | QTI Quantum Telecommunications Italy | Crypta Labs | CRAFT PROSPECT | AUREA TECHNOLOGY

*Source: Stifel**

3.3 THE EMERGENCE OF **IN-ORBIT SERVICES**

Revolutionising Space Operations

Since the launch of Sputnik in 1957, space systems have been built to be operational over their entire mission life cycle without human or physical intervention. Satellites are equipped with all the necessary resources for their entire mission, resulting in redundant and expensive designs, as upgrading or repairing older satellites has not been possible. However, the emergence of spacecraft servicing capabilities is an important development in the space sector today, and spacecraft that undergo regular on-orbit interventions should become increasingly prevalent.

In-orbit services (IOS) refer to a broad suite of on-orbit activities such as repairing, refueling, or transporting another satellite in space. The execution of such tasks in close proximity between two spacecraft requires complex techniques such as rendezvous support technologies, standardized capture interfaces, and detumbling techniques. The technological readiness of In-Orbit services is advancing to new heights, as space close proximity operations have already been developed by public entities, particularly during the ISS programme. In the past 20 years, civil space missions have grown more automated, relying on increased robotics technology while still necessitating some degree of human intervention.

While most IOS technologies are still very early-stage, initiatives are multiplying with a growing interest in developing robotic capabilities and eliminating the need for human presence in in-orbit operations. Current space mission architectures - costly, disposable, and producing ever more debris – are increasingly seen as unsustainable and obsolete. Whilst many challenges remain, this nascent and disruptive activity is often considered a game changer due to its potential to significantly alter the way space systems are designed, manufactured, and operated. Another driver behind the development of in-orbit services is the renewed interest in space exploration with goals to establish a permanent presence on the Moon. These missions will require on-orbit assembly for building large and complex infrastructures such as the NASA Lunar Gateway.

In-Orbit Services definition encompasses a large scope of activities. We identify several IOS areas that are proving more mature in terms of technologies and commercial traction:

- Life extension services propose to repair or upgrade satellites rather than just replacing them. These services have a clear path to a profitable business model, particularly for servicing GEO satellites, which typically cost well over USD 100m to manufacture and deploy. Northrop Grumman MEV programme performed the first-ever docking of a communications satellite in GEO orbit in 2020, and extended its life by five years, marking an industry first. A year later, Northrop Grumman's Space Logistics unit took that feat a step further, docking MEV-2 with an active Intelsat satellite.

- End-of-Life disposal offers to pull space debris to reenter Earth's atmosphere for disposal, reducing collision risks. The generalisation of propulsion mechanisms on LEO satellites to ensure deorbiting is useful but remains exposed to failures and end-of-Life services typically capture and retire LEO satellites using docking plates. Astroscale's ELSA-D spacecraft have successfully performed several rendezvous operations, validating its magnetic docking as a capture system.

- Satellite refueling services refuel or modify satellites in orbit to extend mission lifetime and capabilities and to reduce replacement costs. Orbit Fab plans to deploy gas stations in fab, and has already secured USD21m from the Space Force for three missions demonstrating its capabilities. Orbit Fab also has a contract with Astroscale to refuel its Life Extension spacecraft.

- In-space transportation involves raising the orbit or changing the inclination of a satellite with a space tug. The need for insertion of constellations into their proper orbit is seeing increased interest, as these to go up in record numbers on low-cost rideshare to a non-optimized orbit, and offer a new breed of players an opportunity to offer 'last-mile' solutions, especially in LEO. Exotrail is developing orbital transfer vehicles that will transport payloads to their designed orbits after launch on Isar's Spectrum rocket.

- Space debris removal services apply when debris is already formed. Removing debris can prove highly challenging as, by definition, debris is not prepared for removal and can include rocket upper stages, defunct satellites already in orbit or random pieces resulting from collisions. Active debris removal initiatives remain at a lower development stage, with several demonstration programs under development. Servicers are also used here, but docking plates are not sufficient, mechanic arms can be needed for instance.

Other frontier in-orbit applications are driven by the anticipation of the emergence of an in-space economy, with startups and investors looking to set the foundations of novel industries. Private station developers have successfully secured substantial funding, capitalising on NASA's decision to open up low Earth orbits for commercial purposes, especially as NASA itself sets its sights on establishing a lunar station following the planned discontinuation of the ISS by the end of this decade. In-space R&D and manufacturing start-ups promise to develop and manufacture materials and drugs in the unique environment of space, leveraging advantages such as microgravity. A multitude of lunar and space exploration companies are actively engaged in developing infrastructure and exploring the abundant resources on the Moon and asteroids.

FIG 31: MAPPING OF KEY IN-ORBIT SERVICES PLAYERS

*Source: Stifel**

COMPANY FOCUS

With 13 successful missions already completed, D-Orbit has firmly established itself as a leader in the space logistics and orbital transportation sector. In the early-stage in-orbit services market, D-Orbit stands out from the crowd with an already profitable transport business and a plethora of customers. Typically, satellites take 6 to 10 months to reach their orbital position after a rideshare. ION Satellite Carrier, D-Orbit's orbital transfer vehicle, provides transportation and last-mile delivery to precisely deploy small satellites, reducing the time from launch to operations by up to 85%. ION has successfully launched over 120 payloads into space, solidifying its position as a reliable partner.

As D-Orbit's fleet grows, the company is leveraging ION as a platform to expand beyond space transportation, diversifying its offerings and services at an attractive marginal cost. The company already generates revenues from hosted payload services, enabling customers to validate and demonstrate their payloads in orbit. D-Orbit also provides Satellite-as-a-Service and, for example, has secured a EUR26m contract from the Italian government to supply and manage a SAR satellite as part of the IRIDE program. Additionally, D-Orbit has ventured into space edge and cloud computing services, as ION can also be rented by satellite operators for additional in-orbit storage and computing capacity. D-Orbit's also plans to become prominent player in the in-orbit servicing market, capitalizing on its proven robotic servicing capabilities thanks to its expertise in space transportation.

Space Situational Awareness: growing business opportunities

Space Situational Awareness (SSA) is the ability to understand our orbital environment, such as tracking satellites or forecasting space weather. There are three main categories of SSA services:

- Space surveillance and tracking (SST) focus on the motion and activities of in-orbit objects, both active (such as satellites) and inactive (such as debris).

- Space weather events (SWE) programs ensure coverage of space weather phenomena such solar flares or geomagnetic disturbances, that occur regularly and can cause severe disruption to critical infrastructure.

- Near-Earth Object (NEO) observations search for large asteroids or comets of sizes whose orbits come close to that of Earth's. Less than half of the estimated 25,000 NEOs that are 140 meters and larger in size have been found to date according to NASA. While the chance of hitting Earth is very small, objects of this size pose a risk to Earth of greatest concern due to the level of devastation an impact would cause.

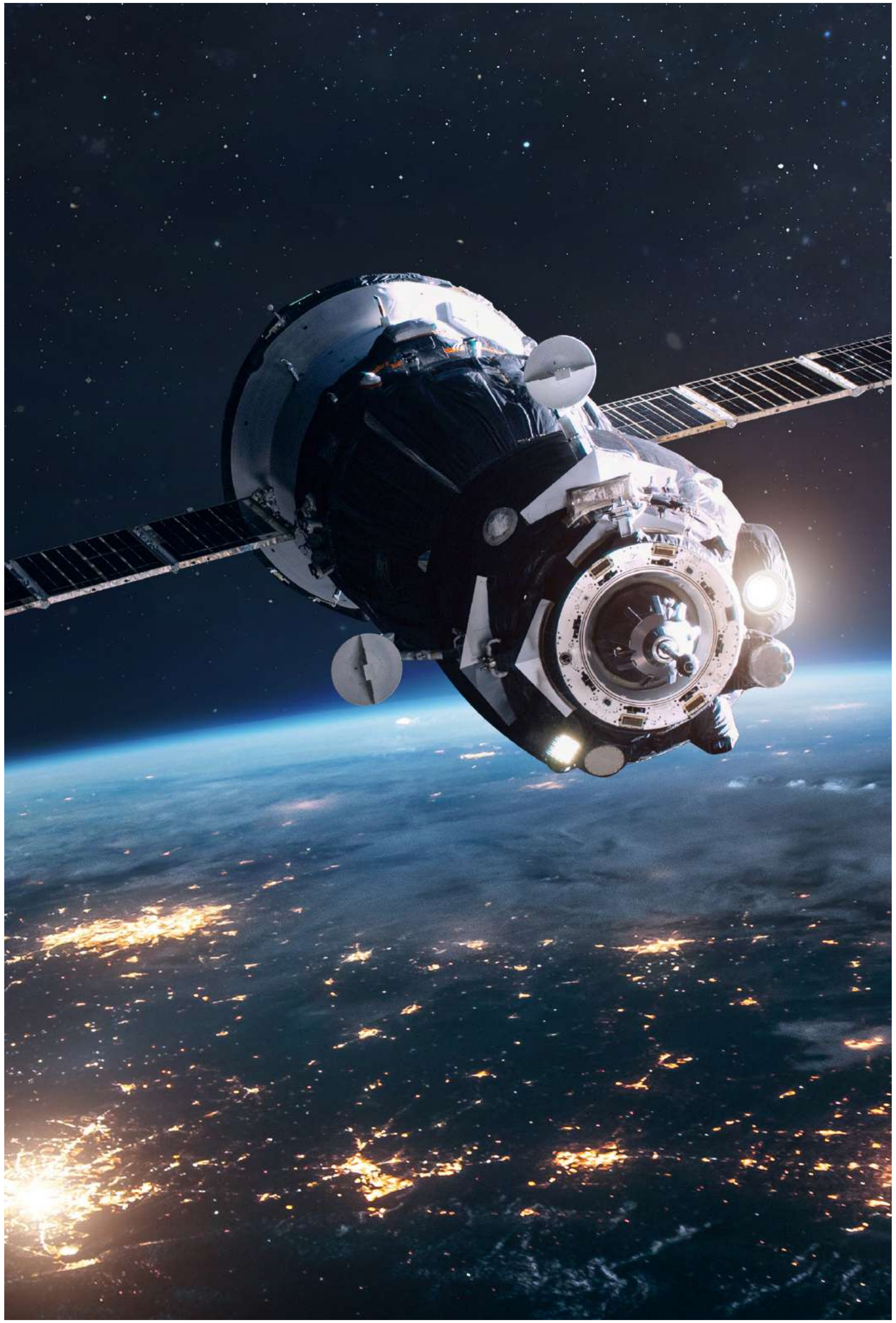
Government agencies have historically been the major SSA players as they have developed capabilities for military, security and defence issues. For years, the space industry has relied solely on government programmes, especially from the US (US Air Force Surveillance Network), to track satellites and debris as no other solutions existed. There is a great need for more complete, accurate and timely data on all objects in space to provide safety space services. The current space surveillance systems will likely prove unable to manage the current growth in traffic. Relying on US governmental services has also raised sovereignty concerns in Europe. Last April, a consortium led by ArianeGroup, alongside Eutelsat and Magellium, was awarded a contract by CNES to bolster the performance of European SSA. The consortium will provide CNES SSA data service through the deployment of multi-orbital optical sensors and the development and implementation of an optical space segment in GTO, to complement ArianeGroup's existing ground-based network.

Nowadays, SSA data collection and distribution are also offered for commercial and civil stakes which prompted private for-profit companies to step into the market. Space is an intrinsically global environment where poor debris mitigation practices quickly affect all operators. The market is gaining from the entry of commercial companies that offer SSA services and data to satellite operators, notably SST services given the risk associated with space debris and rising space traffic.

Only debris of over 10cm is traceable today, using, and only approximately 30,000 objects are currently tracked. It is estimated there are approximately one million in-orbit objects of between 1cm and 10cm. New private initiatives have arisen to provide alternative options to the US Space Surveillance Network. Among the most noticeable private initiatives, we note Leolabs, which relies on radar technologies, and the French company Share my space, which is developing a lower cost optical technology.

FIG 32: MAPPING OF SST PLAYERS

*Source: Stifel**



CHALLENGES IN GENERATING RETURNS FOR **SPACE INVESTORS**

SECTION 4

Space has emerged as a notable investment category, drawing capital inflows of tens of billions of dollars since the beginning of NewSpace. Nevertheless, the challenges of investing in space were apparent during a tumultuous 2022. This year was characterized by a more stringent capital environment and the collapse of growth-oriented technological stocks, with a particular impact on Special Purpose Acquisition Companies (SPACs). However, the space sector demonstrated commendable resilience. Investment within this sphere experienced a slower rate of decline compared to the global tech industry. Aeronautics and Space stocks managed to outperform the broader market. While space-based value-added services, distinguished by their greater market potential and lower capital intensity, continue to exude strong appeal, our contention is that upstream markets, although often narrower and fragmented, can also be highly attractive due to robust government support. In fact, public expenditure retains its pivotal role in shaping the core space economy. The geopolitical tensions of 2022 further bolstered this trajectory.

4.1 **INVESTORS AIM** FOR THE STARS

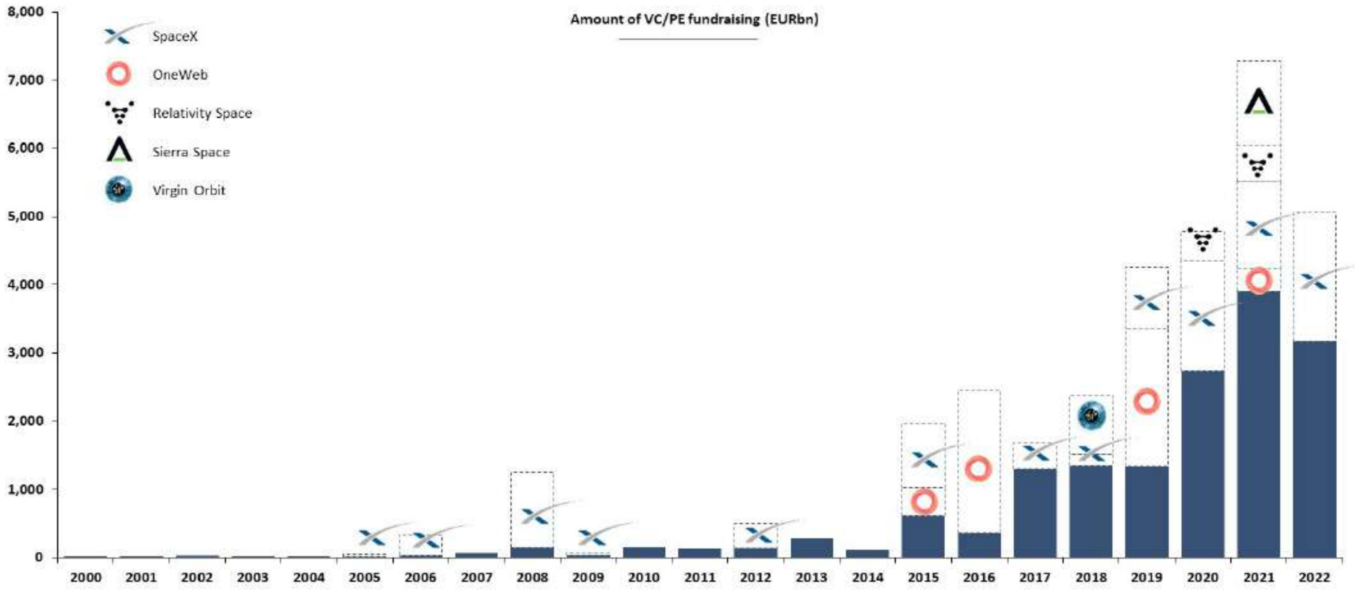
A private investment cycle began with NewSpace

The NewSpace movement emerged around 2010, led by a handful of West Coast start-ups before spreading worldwide. One of the most significant changes of NewSpace is the growing role of private investors and venture capital in the space industry. In recent years, money has been pouring into the space sector: tens of billions of dollars have been invested in NewSpace start-ups since 2010, in the hope to give birth to a dynamic commercial space sector. Venture capital is the main contributor, representing more than half of the funds raised since 2000, with much of the capital flowing to early-stage companies.

While initial investment focused on launchers and space tourism, the NewSpace wave then swept through the whole space sector after the first start-ups confirmed their promises. The main NewSpace projects were initially created by wealthy individuals acting as super-angels, notably SpaceX, Blue Origin, and Virgin Galactic. The risks associated with space ventures are significant, in a sector that is regarded as highly regulated and capital-intensive, with high failure rates and long development cycles. The success of those start-ups that were once regarded with skepticism has, however, set a precedent for the entire movement.

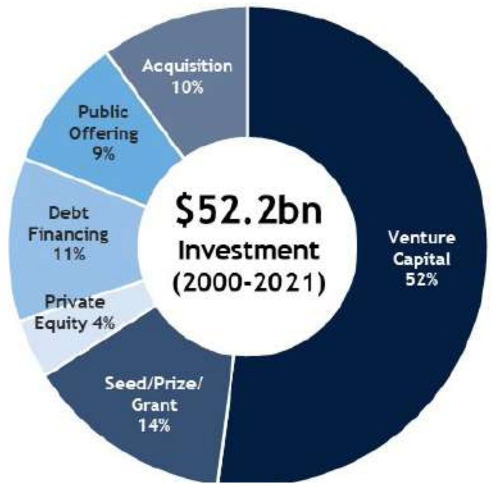
According to our proprietary analysis, 2021 was a record year with Space start-ups attracting EUR7.3bn in funding, almost twice as the EUR4.7bn record set in 2020 and compared with the EUR312m average annual funding in private space start-ups between 2000 and 2015. The number of deals over EUR100m increased from one to two on average between 2012 and 2017 to 14 in 2021, led by the USD1.8bn raised by SpaceX at a valuation above USD100bn.

FIG 33: INVESTMENTS IN START-UP SPACE COMPANIES SINCE 2000 *(IN EURBN)*



*Source: Stifel**

FIG 34: SPACE INVESTMENTS BY TYPE *(2000-2021)*



*Source: BryceTech, Stifel**

2022, a year of resetting

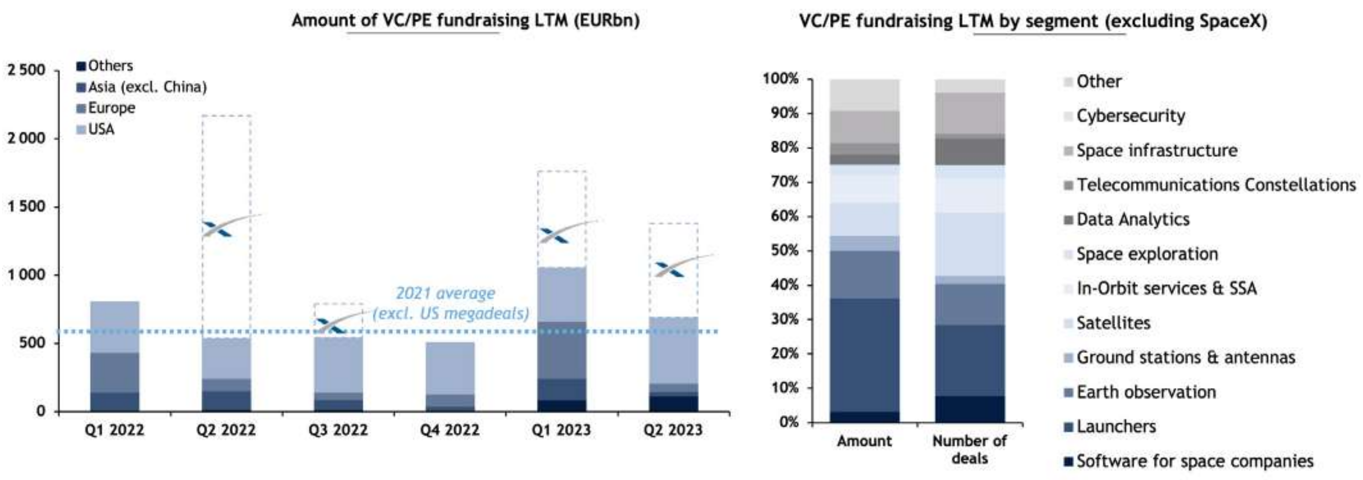
2022 was a challenging year for NewSpace as the end of the near-zero interest rate environment made it more difficult for space startups – and tech at large – to raise money. Consequently, investors have set the bar higher when distributing funds to space ventures, especially since the sector is often perceived as too capital intensive and with long lead times to profitability. Several NewSpace companies, notably the listed ones, have struggled to deliver growth in their revenue streams in recent quarters, and we believe that investors high expectations for the industry's long-term commercial potential have been rebalanced – tempering the hopes that every startup will be as successful as SpaceX.

However, our analysis shows that investment levels remained high compared with historical standards, with cumulative private placements exceeding EUR5bn in 2022. Although there was a 31% decrease from 2021, investments during 2022 still surpass the levels seen in 2020. Furthermore, the drop from 2021 is only 12% when adjusted for the distortion caused by the largest deals – namely from SpaceX, OneWeb, Sierra Space, Relativity & Virgin Galactic.

In the past twelve months, investors have primarily funded Launchers, receiving EUR900m, followed by Earth Observation companies (~EUR350m), Satellite manufacturing (~EUR300m), and In-orbit services & SSA (~EUR350m). These four sectors accounted for 61% of the number of completed deals and 48% of the total investment amount by venture capitalists and private equity firms. Unsurprisingly, the most preferred sectors were either downstream (requiring lower capital intensity), or upstream when supported by significant government backing. Among the 93 fundings completed in Europe since the beginning of 2022, 17 deals were above EUR25m in size. The average deal size in the region was EUR12m.

We believe investments in NewSpace have demonstrated resilience in 2022 thanks to anticipations of heightened government demand for space activities, which should keep governments as an anchor customer for space. Space continues to demonstrate its strategic significance in the global race for military equipment. For example, sovereign constellations are projected to generate substantial demand across the industry, not only in the United States but also in Europe in the coming years. The U.S. and allied governments are increasing their focus on innovative space capabilities, fueled by the war in Ukraine and competition with China's space program. Investment in emerging technologies and capital-intensive applications, such as launchers and in-orbit services, has maintained a strong momentum. It is our belief that the level of government traction a startup possesses has become a crucial factor in capturing investor interest. Conversely, business models emphasizing «growth at all costs» are likely to experience a pullback going forward.

FIG 35: LATEST FUNDRAISINGS WERE DRIVEN BY LAUNCHERS AND EARTH OBSERVATION



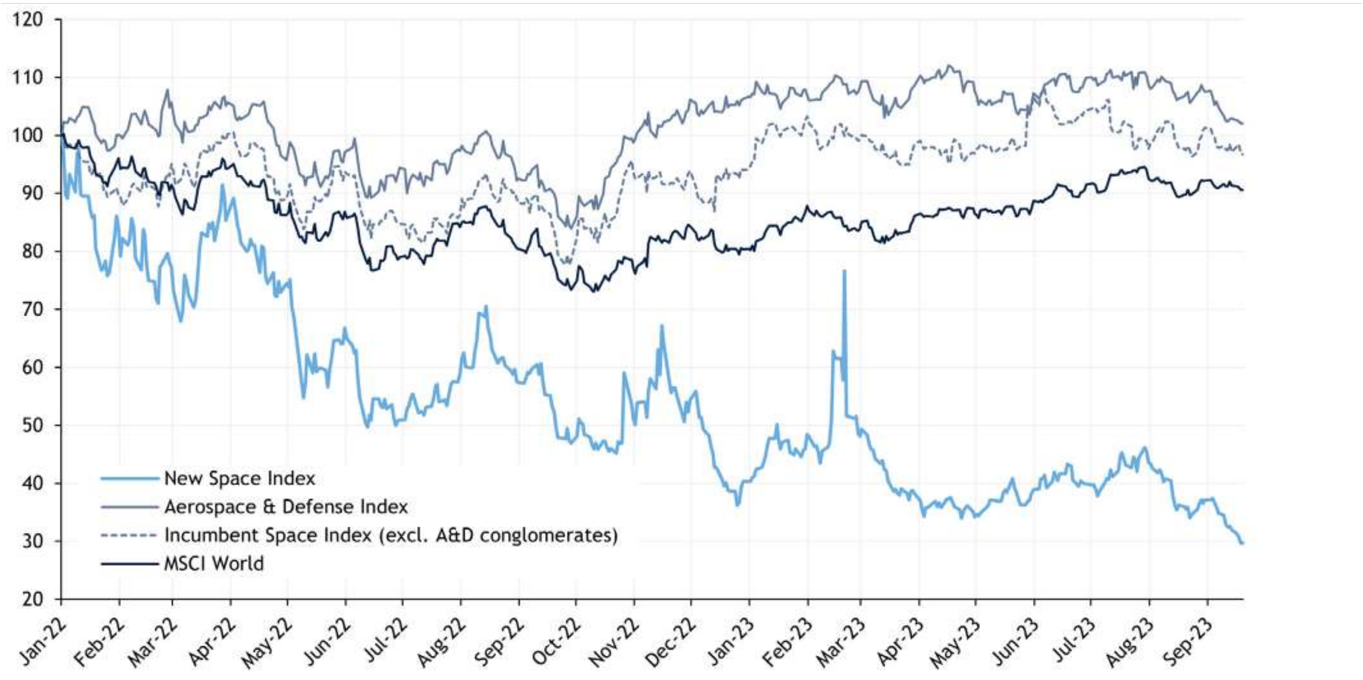
Source: Stifel, Pitchbook*

Following the 2021 NewSpace hype, illustrated with skyrocketing valuations and the SPACs phenomenon, asset prices have returned to much lower levels. Shares of public NewSpace companies, mostly SPACs, have collapsed since January 2022, down -70% according to our NewSpace Index (see below). A few SPACs that were in the works canceled their deals. Yet, our broader Incumbent aerospace index has outperformed the market. Despite competition from megaconstellations such as Starlink and Amazon Kuiper, satellite operators have benefited from partnerships with satellite-based smartphone services such as GlobalStar-Apple and Iridium-Qualcomm. Large aerospace & defence conglomerates have been supported by growing order books following Russia's invasion of Ukraine and heightened fears of conflict occurring in Southeast Asia, and commercial aircraft production recovery.

M&A activity in the New Space industry has surged since the onset of the pandemic, encompassing various subsectors. Legacy operators in Satcom have witnessed consolidation, while Satellite internet distribution services are experiencing vertical integration. Moreover, incumbents have been acquiring NewSpace players, further driving the market's growth. However, consolidation among NewSpace players is still in its early stages, with only a few deals involving the most established companies in the sector.

M&A activity has been high since the pandemic, with all sub sectors of New Space involved: consolidation in Satcom among legacy operators, vertical integration in Satellite internet distribution services, as well as buyouts of NewSpace players by incumbents. Consolidation among NewSpace players remains at an early stage so far, with a few deals involving the most established NewSpace players.

FIG 36: THE AEROSPACE AND DEFENSE SECTOR OUTPERFORMED SINCE JANUARY 2022, WHILE OUR NEWSPACE INDEX STRUGGLED, WEIGHED DOWN BY SPACS AND TECH CRUNCH



Source: Stifel, Refinitiv*

Our incumbent space index includes the following companies : RTX, Boeing, Airbus, Northrop Grumman, Safran, General Dynamics, L3Harris, Thales, Iridium, Aerojet Rocketdyne, Maxar, Viasat, Globalstar, SES, Eutelsat, Echostar, Al Yah Satcoms, Intellian, OHB, Telesat, Comtech, Gilat, Avio, KVH

FIG 37: LIST OF COMPANIES IN OUR NEWSPACE INDEX

New Space Index								
#	Name	Sector	IPO Date	SPAC	Mkt Cap. (USDm)	Mkt Cap. (%)	Perf. Since Jan. 2022	Sales FY 2022 (USDm)
1	Rocket Lab	Launchers	août-21	Yes	2 136	35,4%	-64%	211
2	AST SpaceMobile	Other	avr-21	Yes	879	14,6%	-49%	14
3	Planet Labs	Earth Observation	déc-21	Yes	771	12,8%	-56%	191
4	Virgin Galactic Holdings	Other	oct-19	Yes	701	11,6%	-86%	2
5	Intuitive Machines	Other	févr-23	Yes	347	5,7%	-59%	86
6	Redwire	Other	sept-21	Yes	206	3,4%	-53%	161
7	Terran Orbital	Satellite & other hardware	mars-22	Yes	199	3,3%	-88%	94
8	Blacksky Technology	Earth Observation	sept-21	Yes	166	2,8%	-74%	65
9	Satellogic	Earth Observation	janv-22	Yes	137	2,3%	-84%	5
10	Mynaric	Satellite & other hardware	nov-21		123	2,0%	-63%	5
11	Spire Global	Earth Observation	août-21	Yes	114	1,9%	-81%	80
12	Ovzon	Other	août-20		102	1,7%	-74%	36
13	Satixfy Communications	Satellite & other hardware	mars-22	Yes	48	0,8%	-94%	14
14	Astra Space	Launchers	juil-21	Yes	39	0,6%	-98%	9
15	GomSpace Group	Satellite & other hardware	juin-16		21	0,4%	-82%	19
16	AAC Clyde Space	Satellite & other hardware	déc-16		16	0,3%	-83%	21
17	Sidus Space	Other	déc-21		13	0,2%	-98%	7
18	Astrocast	Other	août-21		12	0,2%	-94%	1
19	Momentus	Other	août-21	Yes	6	0,1%	-99%	0
20	Kleos Space	Earth Observation	août-18		0	0,0%	-100%	0
21	Virgin Orbit	Launchers	déc-21	Yes	0	0,0%	-100%	33
					6 037	100%	-70%	1 055

Source: Stifel, Refinitiv*

FIG 38: TOP FUNDRAISINGS IN EUROPE SINCE JANUARY 2022 *(>EUR15M)*

Date	Target/Investee	Country	Description	Major investors	Last deal size (EURm)	Last deal type	Financing round
May-22	Kpler	BEL	Data Analytics	Insight	200	PE	n.a
Mar-23	isar aerospace	DEU	Launchers	Lombard Odier, EIF, Bayern Kapital	155	VC	Later Stage
Feb-22	ICEYE	FIN	Earth Observation	Seraphim, BAE, EIF, Molten, Space Capital	120	VC	Later Stage
Jan-22	Descartes Underwriting	FRA	Data Analytics	serena, Cathay, Blackfin, Eurazeo, Seaya, mundi ventures	105	VC	Early Stage
Feb-23	exotrail	FRA	In-Orbit services & SSA	bpifrance, Eurazeo, Celad, NCI, iXO, 360 Capital	54	VC	Later Stage
Jan-23	EOSX	ESP	Space exploration	Undisclosed	50	VC	Early Stage
Nov-22	BeZero	GBR	Data Analytics	Quantum Energy Partners, EDF, Hitachi, Molten, QIMA	49	VC	Early Stage
Nov-22	Orbex	GBR	Launchers	The Scottish National Investment Bank, Jacobs, BGF, High-Tech Gründerfonds, Verve Ventures, octopus ventures, Heartcore	47	VC	Later Stage
Jan-23	Reaction Engines	GBR	Launchers	SDF, BAE, Boeing HorizonX, Rolls-Royce	45	VC	Later Stage
Mar-22	KAYRROS	FRA	Data Analytics	Opera, Newspace Capital, bpifrance, European Investment Bank	40	VC	Later Stage
Feb-22	aerospacelab	BEL	Earth Observation	Airbus Ventures, XAnge	40	VC	Early Stage
Feb-23	The Exploration Company	FRA	Space exploration	EQT, RRW, vsquared ventures, Omnes, Schlumberger, partech	40	VC	Early Stage
Jul-23	LEAFSPACE	ITA	Ground stations & antennas	cdp, Neva SGR, Primo Ventures, RedSeed, Whysol	35	VC	Later Stage
May-22	DAWN Aerospace	NLD	Launchers	Undisclosed	28	VC	Later Stage
Jan-23	SATREV	POL	Earth Observation	Virgin Orbit, Millennials	28	VC	Later Stage
Jan-23	clearspace today	CHE	In-Orbit services & SSA	swisscom, OTB	27	VC	Later Stage
Feb-22	cailabs	FRA	Ground stations & antennas	Newspace Capital, starquest, Safran, bpifrance, Innovacom	26	VC	Later Stage
Aug-22	LiveEO	DEU	Data Analytics	Helen Ventures, MMC, Motu Ventures	19	VC	Early Stage
Nov-22	ORORA Technologies	DEU	Earth Observation	Edaphon, space-tec, Plug and Play, Bayern Kapital, APEX Ventures	15	VC	Later Stage

Source: Stifel, Pitchbook*

FIG 39: TOP 20 M&A OPERATIONS WORLDWIDE *(SINCE 01-01-2020)*

Date	Target	Country	Description	Acquirer	Last deal size (EURm)
Aug-23	Ball	USA	Satellites manufacturing & Parts	BAE SYSTEMS	5 036
Dec-22	Aerojet Rocketdyne	USA	Launchers	L3HARRIS FAST. FORWARD.	4 498
Nov-22	LEONARDO DRS	USA	Satcom distributors	SES	503
Nov-22	Avantus	BEL	Satellites manufacturing & Parts	QINETIQ	36
Oct-22	nano avionics	LTU	Satellites manufacturing & Parts	KONGSBERG	51
Jul-22	OneWeb	GBR	Satcom operators	eutelsat	3 315
Jun-22	MARLINK Connect smarter. Anywhere.	FRA	Satcom distributors	PROVIDENCE EQUITY PARTNERS	1 320
Jan-22	SolAero Technologies	USA	Satellites manufacturing & Parts	ROCKETLAB	71
Nov-21	inmarsat	USA	Satcom operators	Viasat	6 320
Nov-21	exactEarth	CAN	Earth Observation	spire	111
Oct-21	ASI by Rocket Lab	USA	Software for space companies	ROCKETLAB	35
Oct-21	SPACECOM Making space feel closer	ISR	Satcom operators	4iG	58
Jul-21	Apollo Fusion	USA	Launchers	ASTRA	59
Apr-21	RigNet	USA	Satcom distributors	Viasat	53
Dec-20	BCT	USA	Satellites manufacturing & Parts	Raytheon Technologies	354
Nov-20	OneWeb	GBR	Satcom operators	HM Government, airtel	848
Nov-20	BRAXTON	USA	Cybersecurity	PARSONS	264
Sep-20	gogo (Commercial Aviation division)	USA	Satcom distributors	INTELSAT	350
Jun-20	SPACEFLIGHT	USA	Satellites manufacturing & Parts	MITSUI & CO.	43
Apr-20	United Technologies	USA	Launchers	Raytheon	30 003
Jan-20	Dynetics	USA	Launchers	leidos	1 477

Source: Stifel, Pitchbook*

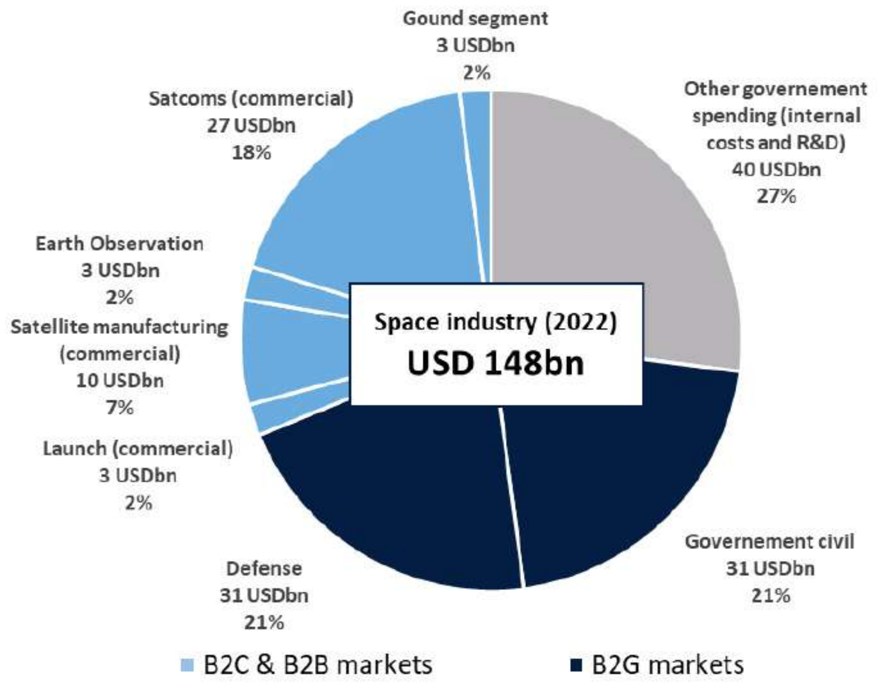
4.2 **INVESTMENT POTENTIAL**: WHICH MARKETS HOLD THE KEY?

The dilemma of a government-dependent industry

Space activities have long been mostly related to public-sector customers or internal activities from space agencies. The return on investment for space activities has been considered uncertain and long-term, making it difficult for private companies to justify the high upfront costs of entering the industry. Today, we estimate that government spending still accounts for more than 60% of the USD148bn core space economy (launch, satellite manufacturing, satellite operations, and ground segment). While we expect B2B and B2C revenues to grow faster, the share of government revenues is projected to remain significant for the foreseeable future.

A core assumption of the NewSpace pioneers is that there is untapped potential in commercial space activities, as evidenced by attempts to pursue consumer markets such as space tourism or B2C broadband connections. The so-called «Democratization of space» implies that commercial interests play a leading role, with NewSpace companies looking at ways to make space more accessible to a broader range of customers through more affordable technologies and approaches.

FIG 40: GOVERNMENT SPACE BUDGETS STILL REPRESENTED ABOUT 60% OF THE CORE SPACE ECONOMY IN 2021



Source: Stifel estimates, based on Euroconsult*

In recent years, the space industry has undoubtedly undergone significant commercialisation in which governments have partnered with private companies. Innovative players are also burgeoning, trying to grow the private sector demand and create large-scale space industries. New types of space-related services have the potential to open up new markets and drive growth in the industry. Main drivers of the new appetite for space activities are needs that can be serviced by space technology, such as global connectivity, Earth Observation, or IoT and M2M.

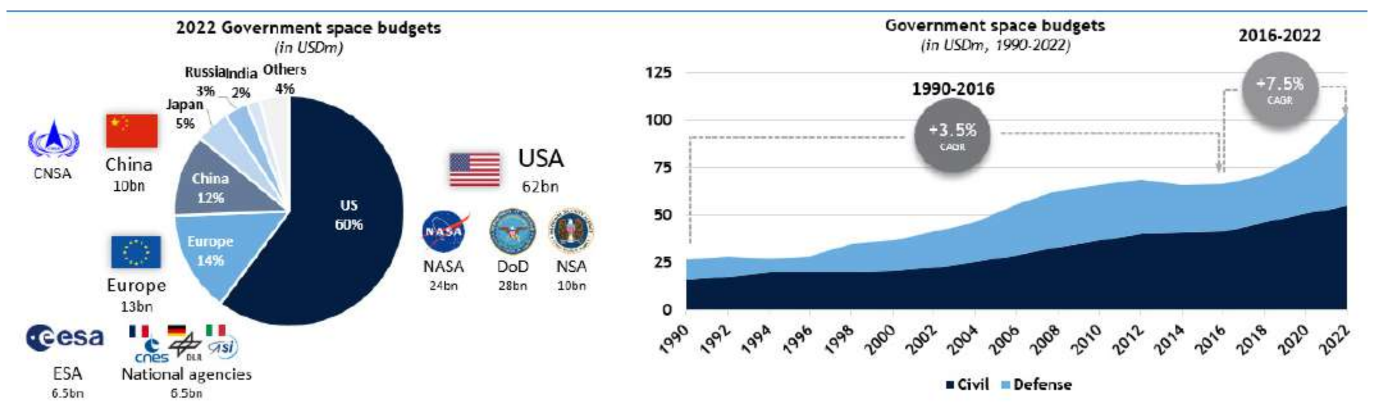
However, the success of the NewSpace movement in generating demand from the private sector has been relatively modest so far, and government space budgets continue to overshadow commercial sector demand. Indeed, many successful NewSpace companies have built business models that rely on both government and private customers. A prime example is SpaceX, which has secured over USD15bn in government contracts since 2003. Although the B2C Starlink business is growing, we estimate the public sector still represented more than half of SpaceX's revenues in 2022. We have identified the following challenges in addressing the commercial, B2B, and B2C space markets:

- Some NewSpace companies have set overly ambitious revenue projections, assuming rapid market penetration and demand. Notably, many SPAC companies have harboured unrealistic expectations regarding the speed of market growth and revenue generation. However, the adoption and uptake of space products and services have been relatively slow. Space commercial markets are still far from maturity it takes time for customers to fully embrace new technologies and offerings.

- Focusing on the commercial and consumer markets makes it harder to monetise innovative capabilities. Public sector customers prioritise performance over cost, while the commercial sector is more price sensitive. Additionally, the cost-conscious approach of NewSpace has often led to deflationary effects, making it challenging to drive market growth in terms of value despite increasing volumes. This dynamic dampens market value unless price elasticities are leveraged to achieve high volumes. However, uncertainties remain regarding the demand elasticity of space offerings for commercial customers.

- Vertical integration among NewSpace players tends to restrict the market accessible to third-party vendors, as evident in the broadband constellations segment, including companies like SpaceX and Amazon.

FIG 41: GOVERNMENT SPACE BUDGETS, 1990-2022 *(IN USDBN)*



Source: Euroconsult

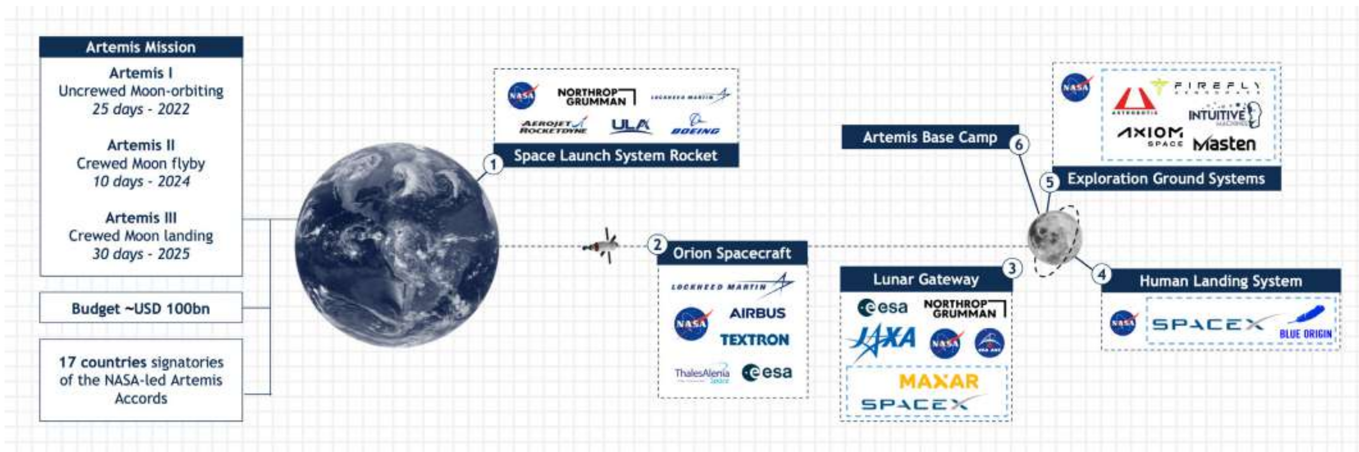
Space budgets: governments are not giving up on space

After decades of centralised control of the space industry, policymakers are increasingly ceding the direction of space activities to commercial companies, starting in the United States, where the Obama administration has sought to promote innovation and reduce costs. Initially gaining momentum through the influence of a handful of wealthy individuals, private sector spending and public-private partnerships are becoming the industry's driving force. It is widely acknowledged that the public sector played a crucial role in the success of the first NewSpace ventures. But increasingly, the affordability of current launch services and low-cost satellites have shattered the main industry barriers to entry and laid the foundations for less government involvement: rocket science is less rocket science than before.

The emergence of NewSpace does not, however, indicate that governments are making room for the private sector by reducing their space budgets. In fact, spending by nations on space activities reached a record high of USD 103 billion in 2022. Government space budgets have increased by more than 50% since 2015, driven in part by the cyclicity of space budgets, but also by more ambitious space exploration civil programmes and record investments in space militarisation. We believe that innovations stemming from the NewSpace movement are reigniting a space race where security and economic sovereignty are at stake, rather than just prestige. Strategic competition with China is increasingly driving US government spending in the space economy. The growing spatial capabilities of China, both civilian and military, and the recent momentum of American space companies, are fanning the flames of the two superpowers' rivalry right into space.

Space budgets have also been on the rise in Europe, as well as investment programs for NewSpace ventures. Europe is facing growing pressure to support its space industry, which is now struggling to keep up with the pace of American innovation. EUR6bn IRIS² sovereign constellation program aims to allocate at least 30% of the EUR2.4bn EU-funded component to start-ups and SMEs. Under the EUR54bn France 2030 investment program, an envelope of EUR1.5bn has been set aside for space technologies. The European launcher industry prepares to get back on track after what has been described as a crisis by former Ariane CEO André-Hubert Roussel. SpaceX clearly dethroned Arianespace in commercial markets, to which are added the delays of Ariane 6, the Vega C's launch failures and the loss of its partnership with the Russian space industry.

FIG 42: THE ARTEMIS MISSION: NASA'S PLAN TO GO TO THE MOON, AND STAY



Source: Stifel*.

Upstream markets: public sector support remains vital

The upstream space sector encompasses satellite design, manufacturing, launch, and operations, as well as the required ground infrastructure. Governments and defence actors dominate the upstream sector, accounting for 72% of the market value in 2022. While commercial clients contribute significantly to the number of satellites launched, they tend to have lower unitary prices, which contribute less to moving the needle of industry revenues. In contrast, defence and civil government actors represent a low volume of launches but with costly, state-of-the-art systems.

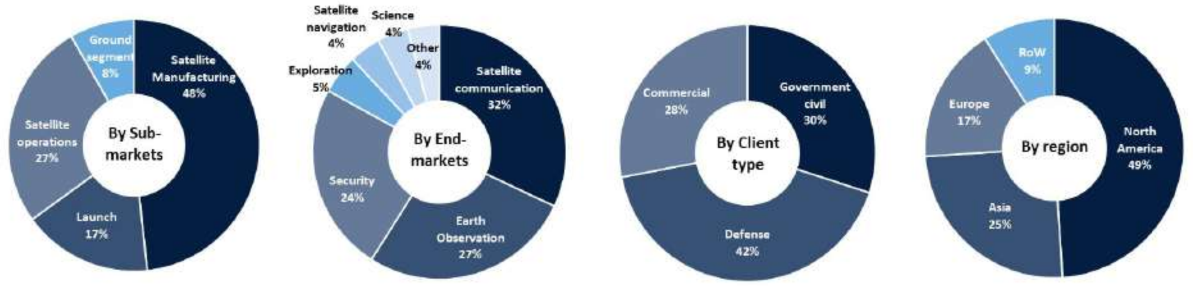
The ongoing surge in satellite launches is undeniably boosting the upstream markets. Satcoms, Earth Observation, and military applications make up over 80% of the upstream markets' value and should drive the growth in the coming years, bolstered by tailwinds such as the multiplication of broadband constellations to serve the downstream market of satellite internet distribution, the rising demand for Earth observation data, and increased spending on defence.

However, we remain cautious about the relatively small size of the upstream space markets in comparison to their capital-intensive nature. The upstream market is highly competitive, and generating attractive ROIs without public partnership is challenging. Optimistic expectations regarding market growth continue to face uncertainties about the elasticity of space markets. A deflationary pricing environment for space hardware, caused by the cost-effectiveness of many NewSpace technologies, may ultimately limit market expansion.

The disruptive environment of the past few years has nevertheless undoubtedly created significant opportunities for new players, as the cards are being reshuffled in the upstream sector. While the market has consolidated around a few large players over the past few decades, NewSpace's disruptions have offered possibilities for start-ups to leapfrog established players, creating opportunities for investors. Sovereignty requirements have led to a geographically fragmented industry, creating opportunities for local differentiation. Governments around the world provide significant support for the upstream sector through tax breaks, subsidies, and partnerships, offering strategic partnership opportunities for start-ups.

It is worth noting that SpaceX has established a prominent position in the upstream space sector, spanning from launch to satellite operations, to the point American and European officials have privately expressed concerns about the risk of a global monopoly in the hands of SpaceX… and its controversial founder, Elon Musk. The need for the emergence of competitors should paradoxically create traction for new entrants.

FIG 43: UPSTREAM SPACE MARKETS – *USD 60BN (2022)*



*Source: Euroconsult, Stifel**

Downstream markets: fast-growth potential

The downstream industry has quite a different landscape, offering features that align better with the more risk-averse investment trends observed in all industries since early 2022. Firstly, most of the downstream addressable market is derived from commercial applications that are more easily addressed by private players. Secondly, downstream start-ups require lower levels of capital and reach cash breakeven much faster. Downstream companies usually do not produce or own space assets, meaning the capital intensity is much lower and go-to-market strategies are faster.

The downstream sector is dominated by commercial users, with space agencies and military departments exerting a relatively lighter influence compared to the upstream sectors. When it comes to the distribution of satcom services, for instance, our estimates suggest that the demand from the military and civil government accounts for merely 10-15% of the revenues generated by commercial operators. Although outsourcing to commercial actors is becoming more common, critical military systems usually remain owned by the Departments of Defence. Civil government space systems, such as EO and navigation systems, are typically offered as free services to companies and the public to support their development.

Defining the scope and size of the downstream sector in space has proven challenging due to the wide reach of the satellite signals and data in the economy. The space industry has been the subject of recurring bullish views in recent years, touting its potential to become a «trillion-dollar economy « in the coming decades. It's worth noting that such broad definitions of the space economy often include a wide range of space-enabled services that use satellite broadcasting, imagery, or navigation. These definitions encompass industries where the share of revenues generated by the upstream sector is minimal, such as the whole satellite and cable television industry, as well as applications that use satellite positioning services like Uber or Snapchat.

Our analysis shows that downstream markets present significant potential for growth, making it an attractive opportunity for investors looking for fast-growth markets. Due to their strong connections to commercial markets, the growth of the downstream sector is less constrained by demand resulting from government budgets, which are unlikely to grow much faster than the low single-digit to mid-single-digit nominal growth of national GDP. We have identified three particularly promising downstream sectors:

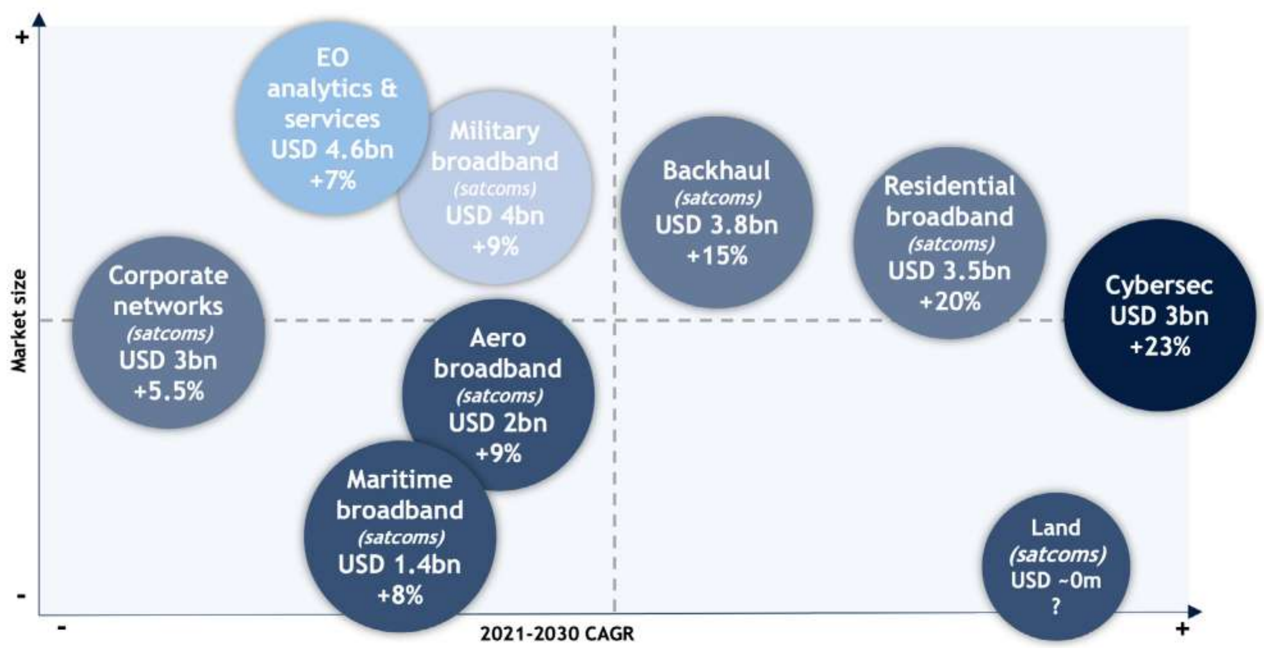
- Broadband satcom services should be driven by demand for «anywhere, anytime» broadband access in underserved areas such as rural, sparsely populated areas, or at sea and in the air. We estimate satcom market growth should run at a 10-12% CAGR between 2021 and 2030, with broadband services reaching a size of USD50bn around 2030, up from USD16bn today. In our base case scenario, we see LEOs megaconstellations gradually taking >50% market share in the broadband segments by 2030. While it should prove hard to compete directly with the likes of SpaceX, Amazon and OneWeb on space infrastructure, their dynamism should open a whole lot of opportunities for distributors and antenna manufacturers.

- Data analytics: as described in section 2.3, analytics platforms can capitalise on the current Earth observation trends, without incurring the capital-intensity associated with launching and operating their own satellites. The EO services market is expected to grow at a 6-7% CAGR over the next 10 years, with start-ups focusing on new applications expected to experience more significant growth.

- Cybersecurity services: as described in section 3.2, cybersecurity threats are becoming a growing concern in the space sector. To mitigate these risks, it will be necessary for companies in the industry to allocate a greater portion of their budget towards investing in cybersecurity services and products. We expect the space cybersecurity market to accelerate sharply in the coming years, ie delivering a 23% CAGR over 2022-2030.

FIG 44: A BROAD RANGE OF FAST GROWING DOWNSTREAM SPACE MARKETS

(2021 MARKET SIZES AND 2021-2030 CAGR FORECASTS)



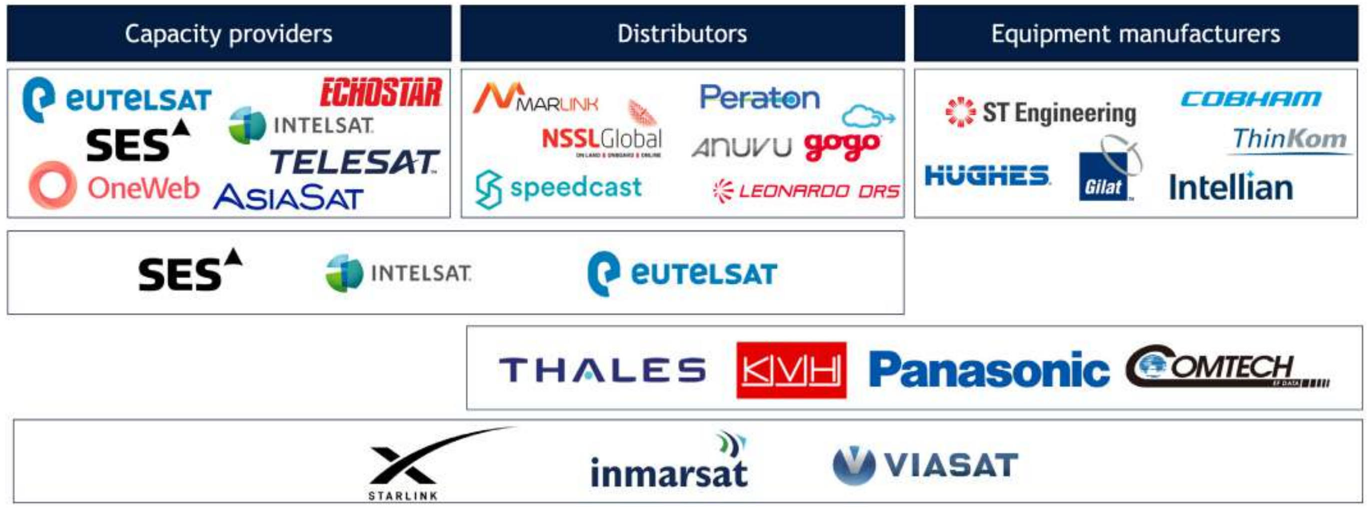
Source: Stifel estimates, based on Euroconsult and NSR forecasts*

Satcom services distributors are strategically positioned to capitalise on the surging demand for satellite connectivity. The advent of LEO constellations presents a game-changing moment for the industry, potentially jeopardising established players. Nevertheless, even the most integrated LEO constellation operators have found value in partnering with distributors. Achieving profitability for these global constellations relies heavily on maximising their fill rate, prompting the need for extensive distribution efforts across the entire planet and multiple verticals. An example of this is Starlink's collaboration with reputable maritime distributors like Marlink and Speedcast.

The widespread adoption of satellite broadband services across various industries and clientele, including retail, airlines, government, and energy companies, underscores the crucial role of specialised knowledge possessed by distributors and integrators. Additionally, as some players in the industry move towards the implementation of multi-orbit strategies, the aggregation function should become increasingly vital.

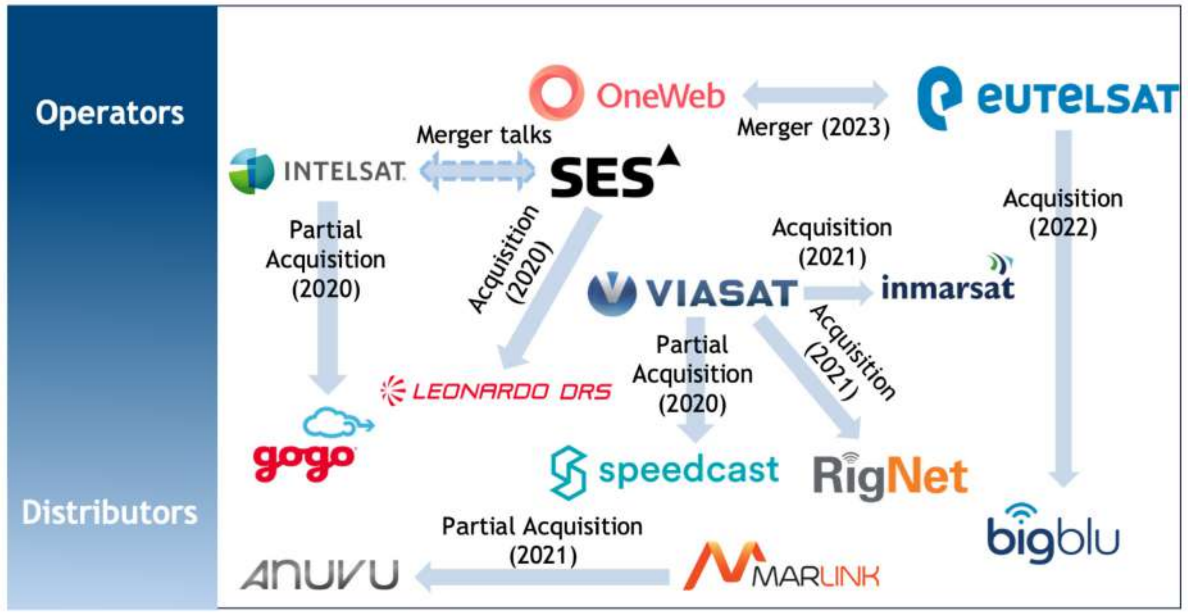
In recent years, the satcom industry has focused on vertical integration, with operators implementing distribution strategies and acquiring service providers. Operators are looking to establish closer relationships with customers to cushion against the increasingly commoditised and competitive wholesale capacity business. Examples of such strategic moves include Viasat's acquisition of Rignet, Intelsat's acquisition of Gogo's commercial IFC division, and SES's acquisition of Leonardo DRS. These actions highlight the recognition of distributors as strategic and valuable assets for legacy operators in the rapidly evolving satcom landscape.

FIG 45: MAPPING OF THE BROADBAND SATCOM INDUSTRY



*Source: Stifel**

FIG 46: SATCOMS HAVE ENTERED A CONSLIDATION CYCLE



*Source: Stifel**

4.3 FINDING THE **FUTURE CHAMPIONS**

Investing in the space sector can be challenging due to the early stage and fragmentation of NewSpace. Although NewSpace has demonstrated the ability to develop complex products more rapidly than traditional standards, the high capital intensity and execution risk of space ventures persist. As macro-conditions shift and capital becomes more expensive, investors are expected to become more selective. Companies with high upfront capital needs and long lead times to revenue are likely to be most impacted by expensive capital.

Despite the challenges, we believe that significant opportunities still exist for investors to profit from the space sector. To identify future space champions, we have listed several criteria that we believe will distinguish them:

- **Support from government-related institutions:** Governments offer significant support to the space industry through various low-cost financing options, such as direct investment, subsidies, and grants. These forms of assistance have proven crucial in transforming seemingly ambitious projects into successful ones. We believe that strategic partnerships are essential for space ventures, especially in capital-intensive applications. Space agencies and the military remain the largest customers in the space sector, and often make attractive targets for businesses.

- **Validated market appeal:** a common challenge faced by space ventures is the lack of established demand for their products or services. Space companies often bet on the emergence of markets that do not yet exist, hoping for a big payoff. Strategic investments from established players can validate that the company is addressing a real market problem or client issue. Ideally governmental entities can act as anchor customers, providing private companies with revenue visibility and time to develop their commercial viability.

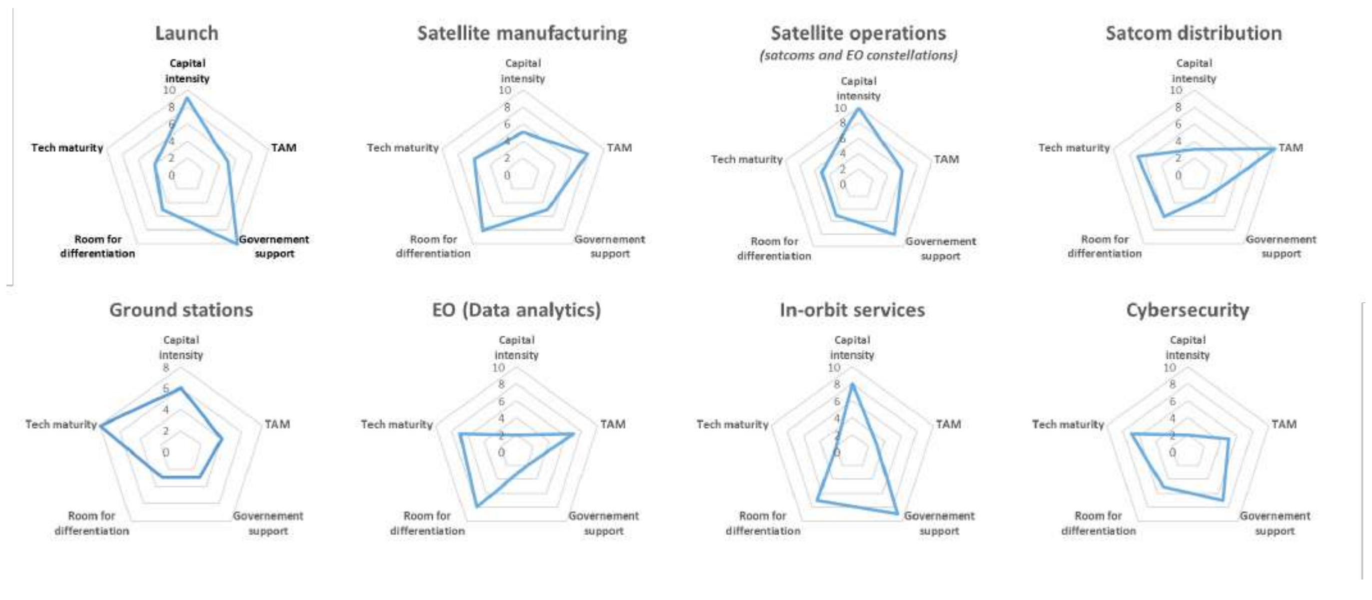
- **Avoid addressing fragmented markets:** it is generally more attractive for space ventures to focus on serving large, well-defined markets. This is especially true in downstream markets, where the customer base may be dispersed and the use cases diverse. Serving fragmented markets often proves challenging in marketing and distributing products to many different customers, in many different sectors.

- **It's not just techno push:** Breakthrough technology in search of monetization can wander in the dark for ages, especially in the space sector where small markets and massive investments intersect. Success ultimately depends on meeting the demands of the market. By letting the market pull, the venture can align its technological developments with actual market needs and increase the chances of success.

- **Experienced leadership:** The space industry is particularly difficult to enter for novice entrepreneurs. Partnering with seasoned executives is often a critical factor in successfully launching a startup in the space industry, which is known for its high barriers to entry, networks and complex regulations.

NewSpace is far from monolithic: within its diverse sub-sectors, we witness significant variations in maturity, funding requirements, and the involvement of the public sector, among other factors. This intricate landscape gives rise to a multitude of diversified investment opportunities, showcasing the breadth and depth of this burgeoning industry.

FIG 47: PROFILING THE SPACE SUBMARKETS: A DIVERSIFIED RANGE OF INVESTMENT CASES



*Source: Stifel**

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WHITE PAPER **AUTHORS**

ANTOINE LEBOURGEOIS
Analyst
Paris
antoine.lebourgeois@stifel.com

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STIFEL | IRIS

INTELLIGENCE • RESEARCH • INSIGHTS • SERVICE

LONDON, UNITED KINGDOM

Stifel Nicolaus Europe Limited
150 Cheapside
London, EC2V 6ET

T: +44 20 7710 7600

FRANKFURT, GERMANY

Stifel Europe AG
Kennedyallee 76
60596 Frankfurt am Main

T: +49 69 788080

LONDON, UNITED KINGDOM

Bryan Garnier & Co Limited
Michelin House 81 Fulham Road
London, SW3 6RD
Tel: +44 20 7332 2500

T: +49 89 2422 62 11

PARIS, FRANCE

Bryan Garnier Securities SAS
26 avenue des Champs-Elysées
75008 Paris

T: +33 1 56 68 75 00

PARIS, FRANCE

Stifel Europe AG – Paris Branch
80 Avenue de la Grande Armée
75017 Paris

T: +33 1 7098 3940

FRANKFURT, GERMANY

Stifel Europe Advisory GmbH
Bockenheimer Landstrasse 24
60323 Frankfurt am Main

T: +49 69 247 4140

MUNICH, GERMANY

Stifel Europe AG – Munich Branch
Maffeistrasse 4
80333 Munich

T: +49 89 9992 9820
T: +49 89 2154 6000

MUNICH, GERMANY

Bryan Garnier & Co GmbH
Königinstraße 9
80539 Munich

T: +49 89 242 262 11

MILAN, ITALY

Stifel Europe AG – Milan Branch
Via Privata Maria Teresa, 8
20123 Milan

T: +39 02 85465761

OSLO, NORWAY

Bryan Garnier & Co AS
Haakon VIIs Gate 1, 2nd Floor
0161 Oslo
Postbox: 0117 Oslo

T: +47 908 45 025

ZURICH, SWITZERLAND

Stifel Schweiz AG
Tessinerplatz 7
8002 Zurich

T: +41 43 888 6100

GENEVA, SWITZERLAND

Stifel Schweiz AG – Geneva Office
Place de la Fusterie 12
1204 Geneva

T: +41 22 994 0610