

**MONTANARO**

ASSET MANAGEMENT

**SPACE:  
THE NEXT  
INVESTABLE  
FRONTIER?**

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**A MONTANARO DEEP DIVE INVESTIGATION**

*Everything has its wonders, even darkness and silence*

HELEN KELLER

## ABOUT MONTANARO

Montanaro (“MAM”) is a specialist investment boutique dedicated to investing globally in quoted Small & MidCap companies. Founded in 1991, we are guided by a simple philosophy: invest in high-quality, growing businesses that can compound their earnings over the long term. We believe smaller companies are the engine of innovation, offering exposure to dynamic and well-managed businesses often overlooked by larger investors.

Privately owned and headquartered in London, Montanaro manages ~£3 billion on behalf of leading financial institutions worldwide. We are one of the few investment managers to be certified as a B Corporation, reflecting our commitment to the highest standards of social and environmental performance.

We define Small & MidCap as companies with market values between £100 million and £20 billion — established enough to be resilient, yet with significant room to grow. Our specialised investment team conducts detailed bottom-up research, with hundreds of company meetings and site visits each year. This hands-on approach helps us understand not only financial performance, but also culture, governance and strategy. We seek exceptional management teams, sustainable competitive advantages and clear paths to profitable growth.

Thematic Deep Dives — on topics such as the transition to net zero or the Space Economy — further inform our investment thinking. They help us anticipate long-term trends and provide a foundation for our engagement and stewardship work.

Engagement is a natural extension of our research: we maintain ongoing dialogue with the companies we own to support strong leadership, effective capital allocation and positive outcomes for shareholders and stakeholders.

**Montanaro combines deep fundamental research with thoughtful stewardship to invest responsibly in high-quality Small & MidCap companies that make a positive contribution to society and deliver long-term value for our clients.**

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# GLOSSARY OF SPACE TERMINOLOGY

**Space Economy** - The full range of economic activities that enable and derive value from human presence in space, including the manufacturing, launch and operation of space assets, as well as the downstream services and data they provide on Earth.

**Upstream** - The design, manufacture and launch of spacecraft, satellites and rockets. The “making and sending” part of the value chain.

**Midstream** - In-orbit infrastructure and services such as satellite operations, data relay, refuelling and space logistics. Sometimes described as “on-orbit economy” or “space infrastructure”.

**Downstream** - The applications and services derived from space-based data and connectivity, for example, navigation, weather forecasting, agriculture analytics, climate monitoring and satellite broadband.

**Low Earth Orbit (LEO)** - The region of space up to roughly 2,000 km above Earth’s surface. It is where most satellites operate, offering lower latency for communications and higher-resolution imaging but shorter orbital lifetimes due to atmospheric drag.

**Medium Earth Orbit (MEO)** - Altitude range between about 2,000 km and 36,000 km. Used primarily for navigation constellations such as GPS, Galileo and GLONASS.

**Geostationary Orbit (GEO)** - A circular orbit at 35,786 km above the equator where satellites appear fixed over one location on Earth. Ideal for broadcasting, weather and some communications services.

**Constellation** - A network of satellites working together to provide global or regional coverage – such as SpaceX’s Starlink or **OneWeb** for broadband internet.

**CubeSat / SmallSat** - Miniaturised satellites built in modular units (typically 10 × 10 × 10 cm cubes). CubeSats have dramatically lowered the cost of accessing space and enabled universities and start-ups to participate.

**Launch Vehicle / Booster** - A rocket designed to deliver payloads into space. Reusable launch systems, pioneered by **SpaceX** and **Rocket Lab**, have cut launch costs by an order of magnitude.

**Reusability** - The ability to recover and re-fly rocket stages or spacecraft components, reducing costs and turnaround time compared to traditional expendable rockets.

**Ground segment** - The Earth-based infrastructure supporting satellites, including ground stations, antennas, mission control and data processing systems.

**Space-enabled services** - Earth-based industries that rely on satellite data or connectivity, e.g. logistics, insurance, finance, agriculture and emergency response.

**Reach products and services** - Commercial activities that extend human or robotic presence beyond Earth, such as lunar transport, asteroid mining or deep-space exploration missions.

**Backbone products and services** - Core technologies and infrastructure that make the space economy function: launch capability, propulsion, sensors, power systems and secure communications.

**In-Orbit Servicing (IOS)** - Operations conducted in space to maintain, repair, refuel, or upgrade satellites and other spacecraft. Seen as a future growth area for sustainability in orbit.

**Space debris / Orbital congestion** - Defunct satellites, spent rocket stages and fragments that pose collision risks to active spacecraft. A major sustainability concern for LEO operations.

**Dual-use technology** - Systems or data that serve both civilian and defence purposes — such as imaging satellites or encrypted communications.

**NewSpace** - A term describing the shift from government-led to commercially driven space activities, characterised by private innovation, venture capital and reduced costs.

**In-Situ Resource Utilisation (ISRU)** - The concept of using local materials in space, for example mining lunar regolith (the layer of loose materials that covers solid rock on a celestial body) to produce fuel or construction materials, to support longer-term missions.

# INTRODUCTION

## The “Homebrew” mentality

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Investing often feels obvious in hindsight. In the 1970s, the Homebrew Computer Club looked like a group of scruffy hobbyists tinkering in garages. Most of their homemade machines never amounted to more than prototypes. But a few — like the Apple I and Altair 8800 — sparked companies that reshaped modern history. Apple, Microsoft and others scaled from garages to global giants, while hundreds of their peers faded away.

The “Space Economy” feels strikingly similar today to the origins of computing. What was once the preserve of superpowers has been reimagined by scrappy start-ups, backed by private capital rather than governments. Rockets and satellites that once consumed entire cities’ worth of infrastructure are being redesigned in sheds, machine shops and hangars by outsiders who refuse to accept that access to orbit should be limited to governments.

The “Homebrew DNA” is unmistakable. *“Infinite Loop: How Apple, the World’s Most Insanely Great Computer Company, Went Insane”* is a fascinating book. Written in 1999, it charts the early years of **Apple**, from garage tinkering and Homebrew meetings through the tumult of the 1990s. Steve Jobs remembered how Steve Wozniak would take him to meetings where hobbyists would compare notes and homemade prototypes.

**Planet Labs** co-founder Will Marshall describes the same thing in Ashlee Vance’s 2023 book, *When the Heavens Went on Sale*<sup>1</sup>: engineers clustering around test sites, swapping ideas, improvising fixes with whatever parts they had to hand. Improvisation, resourcefulness and community knowledge-sharing animate the companies building satellites the size of shoeboxes, designing reusable rockets, and wiring constellations for thousands of spacecraft into global broadband networks.



Image: NASA/Reid Wiseman (@astro\_reid)<sup>2</sup>

Peter Beck, the New Zealand founder of **Rocket Lab**, embodied the same attitude when he began teaching himself rocket science *without a degree*. He manufactured engines in his shed, building what became the Electron rocket. As Beck has said of his approach: *"There are two ways you can learn. You can go to a university and be taught about a shaft breaking, or you can go to industry and have a shaft break."*<sup>3</sup> Apollo 15 astronaut Al Worden, a NASA veteran, observed **Rocket Lab** in action and noted how different it was to his days at the space agency: *"I'm watching these kids with tennis shoes fiddling with the rocket and crawling all over it... It reminded me of a bunch of Silicon Valley kids doing software."*<sup>4</sup>

## Boom, bust, lift-off

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Yet early stage investing in space has proved just as fraught as it was in early computing. A SPAC (Special Purpose Acquisition Company) fuelled boom during 2020–21 flooded the market with speculative capital. Money was invested in pipe dreams, rather than anything capable of generating a profit. Dozens of companies promised the stars: daily Earth imagery, orbital refuelling stations, point-to-point hypersonic cargo delivery. Valuations soared on glossy investor decks and aggressive forecasts (much like elements of the current AI boom). The bubble duly burst. Share prices collapsed, some by as much as 90%.

Yet just as most Homebrew projects ended up in attics, the collapse cleared the field for the handful of firms with genuine staying power. Companies like **Rocket Lab**, **Planet Labs** and **Redwire** established track records of execution, securing government and commercial contracts, and building differentiated niches. In Europe, **OHB** and **Avio** developed and now play vital roles in the continental ecosystem; in Canada, **MDA Space** provides robotics and satellite systems with proven cash-flow. Some are no longer vulnerable start-ups, loss-makers supported by hopeful Venture Capital. They are profitable operating companies in the quoted Small & MidCap space.



Image: SpaceX, Starship Test Flight Mission<sup>5</sup>

## The Small & MidCap opportunity

This matters because the opportunity is enormous. The global space economy was worth around \$600 billion in 2023. McKinsey and the World Economic Forum forecast it could reach \$1.8 trillion by 2035 (such estimates vary depending on how you slice and dice it - and how futuristic you are willing to get!).

The value chain stretches from upstream launch and satellite manufacturing, through midstream services like in-orbit logistics and space stations, to downstream applications in broadband, earth observation, agriculture, finance and climate monitoring. Add in the enabling technologies, such as AI analytics, advanced materials and cybersecurity, and the investable frontier expands further. A result is that Earth is being captured, monitored and recorded on a daily basis like never before.

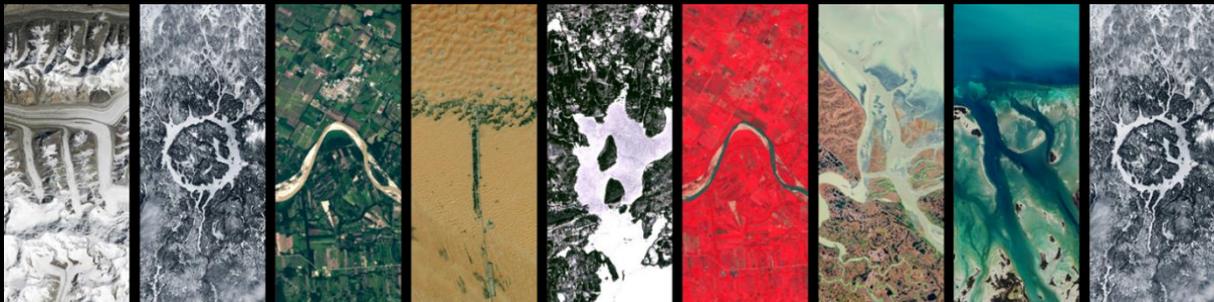


Image: NASA, the “Montanaro” name captured by the NASA Landsat satellite<sup>6</sup>

What makes this exciting for Small & MidCap investors is that *“the companies that are doing things in space aren’t the companies that you would think of right away. It’s all new. It’s the guy who’s made a sensor to go into a building to measure something and then all of a sudden realises that he can put that on orbit and provide that technology to the whole world on a global scale”*<sup>7</sup>.

Some caution is needed, however. Space is not just exhilarating; it is also unforgiving. Rockets explode. Satellites fail. Regulatory regimes evolve slowly. Spectrum and orbital slots are finite. Parts of the industry are capital intensive and dominated by giants – **SpaceX, Blue Origin, Boeing, Airbus** — that can outspend smaller rivals.

Indeed, the raw scientific challenges of space are worth appreciating at the outset:

*“To reach orbit, you need to travel about twenty-seven times the speed of sound, powered by propellants that make up eighty-five percent of your mass...”*

*“The laws of fluid dynamics make it hard; the laws of material science make it hard. What we call burning is really a constant explosion being contained and shaped...”*

*“At Max Q, the rocket faces pressures seventy-five times greater than a Category 5 hurricane”*

**PETER BECK, FOUNDER & CEO, ROCKET LAB**



Image: Brady Kenniston, Rocket Lab, ELaN19 engines<sup>8</sup>

Still, history suggests that frontiers are where outsized returns are made. Nolan Bushnell, the founder of Atari, once turned down the chance to invest \$50,000 for a one-third stake in **Apple**. It would be worth tens of billions today. His explanation was that he was too busy running his own business to take a risk on two kids with a vision. Those who underestimate the “*garage tinkers*” of space may one day also regret it.

**This Deep Dive aims to take a sober, thematic look at the investment case for space from our perspective as Small & MidCap investors.** This is an area that we have been following for over a decade since first reviewing the European launch vehicle sub-sector. Back then, investable ideas were few and far between. We will show you that today, investable opportunities abound – beyond the behemoths like **SpaceX** – with more in the pipeline.

We will explore the growing “Space Economy” to understand the scale of change taking shape beyond Earth’s atmosphere. Is this the next great transition, echoing the energy revolution? A transformation as profound as the Industrial Revolution? Or the dawn of an economy so new it defies our imagination? Only time will tell.

This is one of many Deep Dive reports that we have written. Our timing has normally been good. We wrote a Supply Chain Deep Dive in 2018, just before it became paramount to understand supply chains amid a global economic lockdown. In 2021, we wrote a report investigating the energy consumption of data centres, which has proven useful in the wake of the AI boom. Our other Deep Dive reports include our Net Zero Carbon series; The Built Environment; Hydropower; Biodiversity; Plastic; and Biomass. They can be accessed here: <https://montanaro.co.uk/deep-dives>

**We hope this report proves equally valuable as the future unfolds and we discover whether space truly is the next investable frontier.**

# COLD WAR TO CAPITALISM: A SPACE REVOLUTION

## The Space Age

For most of human history, progress has unfolded at a *glacial* pace. From the invention of tools and fire to the dawn of agriculture and writing, technological leaps were separated by tens of thousands of years. Such a pace is difficult for those of us alive today to comprehend. By the 19th and 20th centuries, things changed. Innovation had begun to accelerate at an unprecedented rate as first the Industrial Revolution and then Technology Revolution took hold.



Chart: Our World in Data<sup>9</sup>

Against this recent backdrop of exponential change, a single event in 1957 marked one of humanity's most profound turning points: the beginning of the **Space Age**. On 4 October that year, a sphere the size of a beach ball soared into orbit atop a Soviet R-7 missile<sup>10</sup>. This was **Sputnik 1**, the first artificial satellite, transmitting a simple 'beep' on shortwave radio on its 98-minute elliptical orbit of Earth. The American public, in the grip of the Cold War, watched on in shock, awe, fear and humiliation. From this single event arose the national competition that fuelled the **Space Race**.

It is not our intention to summarise the history of humanity in space here; there are better sources for this, such as *The Smithsonian History of Space Exploration: From the Ancient World to the Extraterrestrial Future*, by Roger Launius, former Chief Historian at NASA, or *Apollo Remastered* by Andy Saunders (a favourite of ours is *Lost Moon* by Jim Lovell, the Flight Commander of Apollo 13, which includes an insight into the early years of the Space Race). Or even the online J.F.K library and museum<sup>11</sup>.

*"We choose to go to the moon. We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win, and the others, too"*

Address at Rice University on the Nation's Space Effort. 12 September 1962

**PRESIDENT JOHN F. KENNEDY**



Image: NASA, JFK's ambition to go to the Moon<sup>12</sup>

Rather, what we want to comment on is the trajectory of the Space Age and how over a generation, it has moved from one of purely governmental power and geopolitical competition, to one increasingly defined by the private sector. **It is here that the investment opportunity exists.**

A significant driver of the eventual pivot to the private sector was cost: space had become too expensive in the wake of the Apollo programme, even as the US government tried to transition to a more reusable rocket with the Space Shuttle<sup>13</sup>, a machine the height of a 14-story building, filled with 2,000 tonnes of solid and liquid fuels. The aim was to make spaceflight cheaper and routine. Instead, it became synonymous with government cost and bureaucracy. It was also tragically unsafe as evidenced by the Challenger (1986) and Columbia (2003) disasters.

Europe, Japan, China and India gradually built their own government space programmes. Yet the overall model remained the same: large, national agencies contracting with a few aerospace giants — **Boeing, Lockheed Martin, Airbus, Roscosmos** (Russian) — to build bespoke systems at high cost.

## The seeds of “NewSpace”

Even during this government-dominated era, commercial applications began to emerge. By the 1960s, **communications satellites** like Telstar and Intelsat were relaying television and telephone signals across oceans. The **Global Positioning System (GPS)**, developed by the US military in the 1970s and 1980s, eventually transformed into a free, global utility underpinning logistics, navigation and everyday smartphone use. **Weather satellites** revolutionised forecasting and disaster response (something we touch on later in the report).

These services proved that space technology could generate economic value on Earth. Yet the underlying infrastructure — the launch vehicles, satellites and ground stations — was still designed, owned and largely paid for by governments. Costs remained high, measured in billions. The idea that small, privately funded companies might one day build rockets or constellations of satellites was almost unthinkable.

By the 1990s, a new wave of optimism emerged around **satellite communications megaprojects**. **Iridium, Globalstar** and **Teledesic** sought to build constellations to provide global mobile telephony and internet. The technology was ahead of its time. **Iridium** filed for bankruptcy in 1999; **Teledesic**, backed by Bill Gates and Craig McCaw, collapsed before it even launched. Investors were chastened. “Space” once again looked like a graveyard for capital.

### Top 10 historic space moments

#### 1957 – Sputnik 1 (USSR)

First artificial satellite: the Space Age begins

#### 1961 – Yuri Gagarin, Vostok 1 (USSR)

First human in space: the orbit that changed history

#### 1969 – Apollo 11 (US)

First humans walk on the Moon

#### 1977 – Voyager 1 & 2 (US)

Probes begin their journey beyond the Solar System

#### 1981 – Space Shuttle Columbia (US)

First reusable spacecraft launches

#### 1990 – Hubble Space Telescope (NASA/ESA)

Opens a new window on the universe

#### 1998 – International Space Station

Global partnership creates humanity’s orbital home

#### 2020 – SpaceX Crew Dragon Demo-2 (US)

First commercial crewed flight to orbit — human spaceflight returns to the US

#### 2021 – James Webb Space Telescope

Reveals the earliest galaxies ever seen

#### 2023 – Chandrayaan-3 (India)

First landing near the Moon’s south pole



Image: Unsplash, The Space Shuttle taking off<sup>14</sup>

## Enter the entrepreneurs

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The turning point came in the early 2000s, when a generation of entrepreneurs with fortunes from the internet boom turned their eyes upward: Jeff Bezos established **Blue Origin** in 2000; Elon Musk founded **SpaceX** in 2002; and Richard Branson launched **Virgin Galactic** in 2004.

Musk's story has become legend. After a failed attempt to buy refurbished rockets from Russia, he concluded that he could build his own more cheaply. There is a brilliant section in Walter Isaacson's



Image: SpaceX, flickr. Starlink Mission<sup>16</sup>

biography, *Elon Musk*<sup>15</sup>, that describes how, on the flight home from Russia, Musk sketched out a spreadsheet of the raw materials required to build a rocket and realised the markup was astronomical. Rockets, he reasoned, could be dramatically cheaper if built from first principles. **SpaceX's** first rocket, the Falcon 1, succeeded on its fourth attempt in 2008 — just as the company was on the brink of collapse. NASA, seeking cheaper options for resupplying the International Space Station, awarded **SpaceX** a contract that year which effectively saved the company.

Bezos' **Blue Origin** has moved more slowly but pursued similarly ambitious goals, developing reusable suborbital vehicles and working on the heavy-lift New Glenn rocket. Branson's **Virgin Galactic** focused on suborbital space tourism, offering a taste of the frontier for private citizens.

Meanwhile, smaller entrepreneurs followed: **Peter Beck** in New Zealand founded **Rocket Lab**, developing the lightweight Electron rocket tailored to the small-satellite market; in San Francisco, ex-NASA engineers founded **Planet Labs**, launching shoebox-sized "Dove" satellites to image the entire Earth daily. The era of "**NewSpace**" had arrived: space was no longer solely the domain of states and aerospace giants, but of venture-backed start-ups, scrappy engineers and commercial ambition.

This entrepreneurial surge unfolded against a backdrop of rising capability elsewhere. China built the world's most vertically integrated, state-led space programme — operating its own space station, running advanced lunar exploration missions and deploying heavy-lift rockets alongside a rapidly expanding commercial sector aligned with national strategic goals.

India, meanwhile, has emerged as a cost-efficient powerhouse: ISRO's Chandrayaan-3 achieved the first successful landing near the lunar south pole, while the PSLV and LVM3 rockets now anchor a growing domestic and international commercial launch market. These parallel models — state-directed expansion in China and low-cost engineering excellence in India — set the stage for the entrepreneurial NewSpace revolution that followed in the US, Europe and beyond.

## A NewSpace ecosystem

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By the 2010s, several trends converged to make commercial space viable:

- **Miniaturisation:** advances in electronics allowed satellites to shrink from bus-sized to shoebox-sized.
- **Standardisation:** the CubeSat form factor made design and integration easier for universities and start-ups.
- **Cheap launch:** SpaceX and later Rocket Lab, slashed the cost of reaching orbit.
- **Private capital:** venture funds, family offices and later SPACs poured billions into the sector.



Image: CubeSat artist rendering and NASA M-Cubed/COVE (NASA/JPL-Caltech/Montana State University)<sup>17</sup>

The result was an explosion of activity. Hundreds of companies emerged, tackling every niche from propulsion to data analytics. Some built **mega-constellations** (Starlink, OneWeb, Kuiper) to deliver broadband internet. Others focused on **Earth observation**, using radar, infrared or radio-frequency sensing to monitor the planet in near real-time. Still others explored **in-orbit servicing**, **space debris removal** and even early plans for lunar mining or space manufacturing.

Governments adapted. **NASA's embrace of public–private partnerships**, beginning with the Commercial Orbital Transportation Services programme, created steady revenue streams for firms like SpaceX and Orbital Sciences. The US Department of Defense began procuring services from commercial operators. Europe, Japan and others followed suit, contracting with start-ups and SMEs alongside legacy incumbents.

The investment community, once burned by Iridium, re-engaged with gusto. Between 2015 and 2021, venture capital into space start-ups rose every year, peaking during the 2020–2021 SPAC boom. Companies like Virgin Galactic, Rocket Lab, Planet Labs, Spire and Astra listed via special purpose acquisition companies, raising large sums and promising rapid growth.

## Boom, bust...maturity

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The boom turned to bust quickly. By 2022, rising interest rates and missed projections saw most space SPACs collapse in value. Virgin Orbit went bankrupt. Astra retreated from launch to focus on spacecraft engines. Valuations across the sector reset sharply. For many, it looked like a replay of the 1990s satellite bubble.

Yet, as with the Homebrew Computer Club, failure is part of the story. The majority of early ventures fail, but a minority endure and scale. Even after the SPAC wreckage, companies like Rocket Lab and Planet Labs continued to grow revenues and win contracts. Redwire built a portfolio of space infrastructure businesses. OHB in Germany and Avio in Italy remained key European players. MDA Space in Canada returned to the public markets with steady revenues from robotics and satellite systems.



Image: EnMAP, OHB<sup>18</sup>

This is the stage of emergence: when hype has subsided, but genuine businesses begin to stand out. **SpaceX**, still private, dominates launch and satellite broadband. **Blue Origin** and others continue development. But for public investors, the investable frontier increasingly lies in **Small & MidCap companies** that provide critical technologies, services and data.

## **From Cold War to Capitalism**

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The arc of the past seventy years is clear. Space began as the ultimate expression of state power — Sputnik, Apollo, the Shuttle. It evolved into a domain with commercial applications, but still dominated by government procurement. In the past two decades, however, the model has shifted decisively. Costs have collapsed, start-ups have proliferated and commercial business models have emerged.

The space economy today is not just about prestige launches or grand exploration projects. **It is about connectivity, data and infrastructure that underpin life on Earth:** broadband to rural villages, geospatial intelligence for agriculture and finance, climate monitoring from orbit. Space is becoming a critical layer of the global economy.

This transformation mirrors other technological revolutions. Just as personal computers and the internet moved from government labs to garages and then to every pocket, so too is space moving from Apollo and Soyuz to small, venture-funded companies, and perhaps eventually into mainstream portfolios. The **Homebrew Computer Club spirit** — improvisation, knowledge-sharing, disruptive ambition — is alive in the new rocket labs and satellite workshops of today.

For investors, the lesson is both cautionary and compelling. Early-stage hype is dangerous; the SPAC bust proved that. Now, however, a new generation of space companies is building durable businesses. From state monopoly to commercial frontier, the history of space suggests that the most exciting chapter may be the one unfolding now.

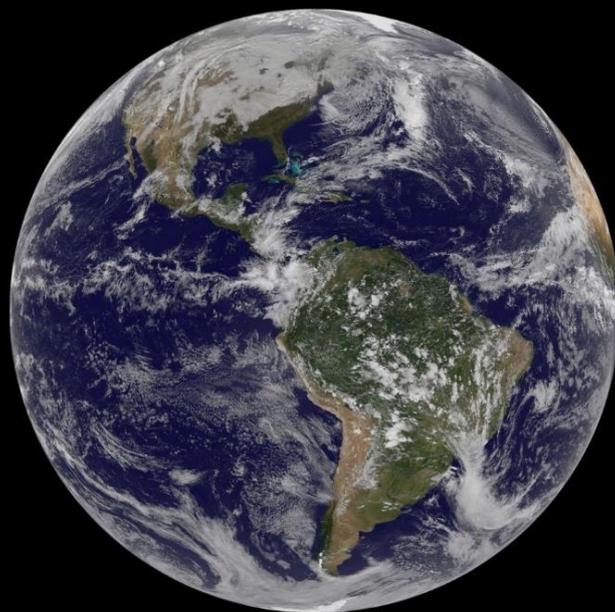


Image: NASA, Earth observation image<sup>19</sup>

# THE SPACE ECONOMY

## The present day

As Space has expanded beyond the domain of governments alone it has become a large and growing economic sector. Definitions of the “Space Economy” vary widely, but analysts generally distinguish between **upstream** activities (launch, manufacturing, propulsion), **midstream** services (in-orbit logistics, space stations, refuelling) and **downstream** applications (satellite communications, Earth-observation data, position/navigation/timing and related services).

Many studies differentiate between “**backbone**” and “**reach**” applications. The backbone refers to the core physical and technological infrastructure of the space economy – the systems that build, launch and operate satellites and supporting networks. “**Reach**” applications describe terrestrial businesses (ride-hailing, agriculture, logistics, fintech) that rely on satellite signals or space-derived data.

We explore each of these segments in detail in the next chapter, where **we have established our own breakdown of the space economy**, which we hope will help in the understanding of the relationships between these segments and the companies that operate within them.

This is necessary as the boundaries between these segments differ across reports: estimates for the space economy’s current size range from about **\$570 billion to \$630 billion**, and even higher when broader “space-enabled” revenues are counted. **The important fact to note though is that almost all projections indicate growth rates far above global GDP.**

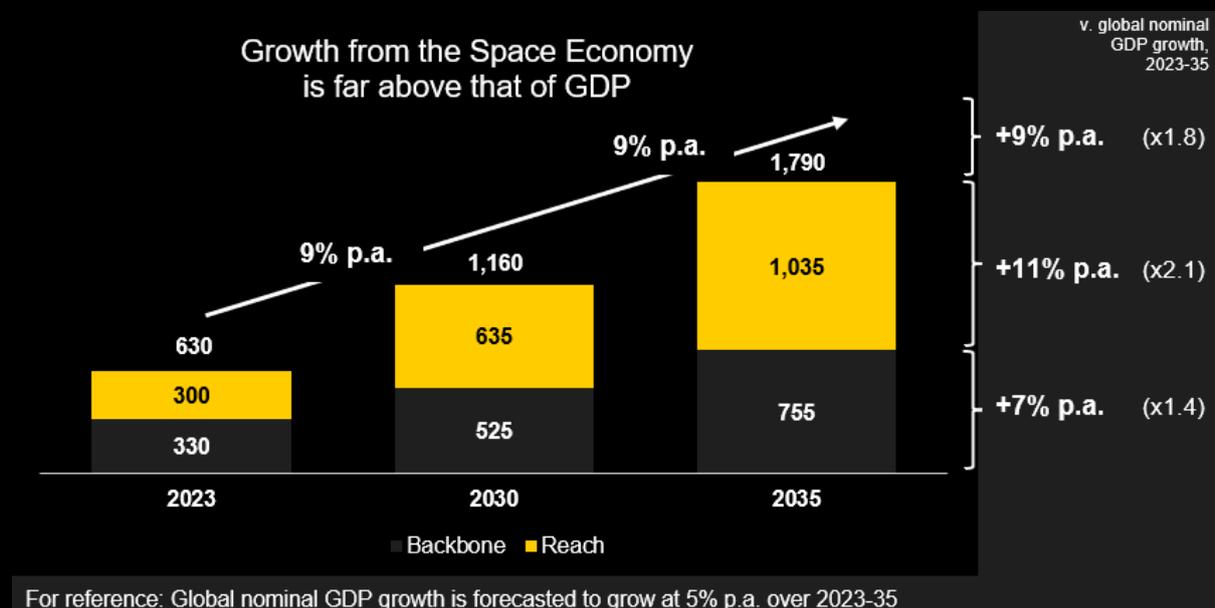


Chart: McKinsey & Company and World Economic Forum, MAM edit<sup>20</sup>

## Projections: a trillion-dollar or two-trillion-dollar future?

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### **The \$944 billion by 2033 forecast (Novaspace, Space Economy Review)**

Novaspace, in its 2024 review, offers the most conservative projection of four reports that we reviewed. It estimates that the space economy will grow from \$596 billion in 2024 to \$944 billion by 2033. This forecast still implies a healthy growth rate (~5.5% per year) but is reflective of a narrower scope focusing on the core space sector and selected downstream services. Novaspace points to increasing consolidation and notes that many early-stage “NewSpace” ventures have struggled to generate returns; however, the firm still expects downstream solutions and government defence spending to drive robust expansion.

### **The \$1 trillion milestone by 2032 (Space Foundation, The Space Report, Q2 2025)**

Space Foundation analysts project that the global space economy could surpass \$1 trillion as soon as 2032. Their projection is grounded in continued commercial growth in satellite broadband and earth observation, coupled with increasing government spending on defence and exploration. This forecast assumes roughly 7–8% annual growth, consistent with the 7.8% year-on-year expansion observed in 2024.

### **The \$1.8 trillion by 2035 scenario (McKinsey/WEF, The Next Trillion-Dollar Industry)**

A more expansive view comes from a McKinsey/WEF report. It predicts that the global Space Economy will climb from \$630 billion in 2023 to \$1.8 trillion by 2035, implying an average annual growth rate of around 9%. This estimate includes both backbone and reach revenues and emphasises the potential for space technology to transform industries such as logistics, agriculture, retail and defence. The report argues that declining launch and satellite manufacturing costs, combined with advances in AI and data analytics, will unlock new revenue streams and drive broad-based economic impact.

### **The \$2 trillion by 2040 projection (PwC Unlocking Trillion-Dollar Growth Opportunities)**

Some analysts project even larger figures. PwC suggests that the global space economy may grow to \$2 trillion by 2040. This long-term outlook assumes that launch costs and satellite manufacturing costs continue to decline and that new markets emerge in areas such as lunar infrastructure, orbital manufacturing and space-based energy. PwC emphasises that private companies are likely to drive much of the innovation needed to achieve this growth, although governments will remain important partners.

## Who drives the growth?

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While the above projections vary, they all reflect the same underlying trend: a structural shift from government-led programmes to commercial enterprise. According to PwC<sup>21</sup>, private revenues now account for around 80% of the space economy, a figure echoed by the Space Foundation<sup>22</sup>, which estimated that commercial activity represented 78% of global space revenues in 2024. Most of this comes from satellite communications — still the industry’s largest segment — though Earth observation and navigation services are growing quickly.

Governments nevertheless remain critical anchors. Novaspace<sup>23</sup> reports that public space investment rose from \$117 billion in 2023 to \$135 billion in 2024, underpinning defence, exploration and science programmes that sustain demand for launch and manufacturing. Commercial R&D spending is rising faster (22% per year versus roughly 10% for US government outlays according to the same report), yet the absolute scale of government funding continues to set the baseline for global space activity.

## The Global Space Economy 2024 (USD billion)

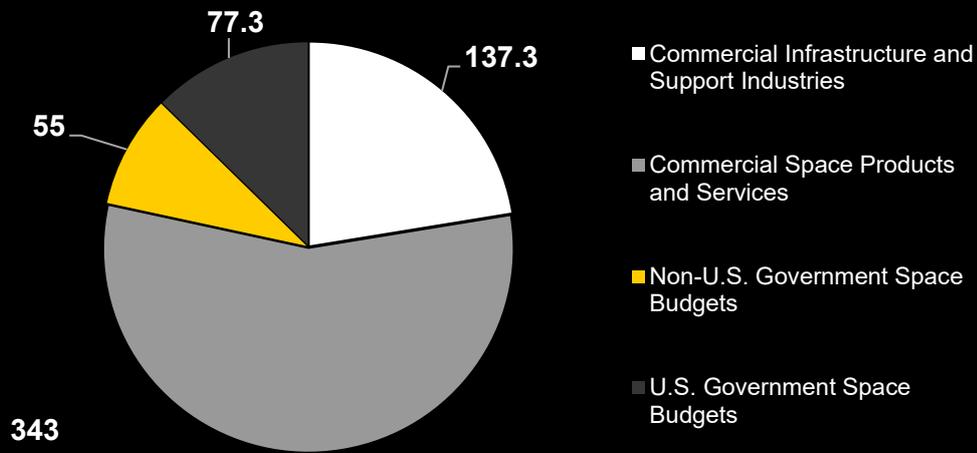


Chart: Space Foundation, MAM edit<sup>24</sup>

### Falling costs

This shift towards commercial leadership is possible due to the dramatic reduction in the cost of accessing and operating in space. Launch costs have fallen ten-fold over the past 20 years<sup>25</sup> thanks to reusable rockets. PwC observes that innovations have enabled greater private-sector participation<sup>26</sup>; commercial launch providers such as SpaceX now support high flight cadences, encouraging deployment of large constellations.

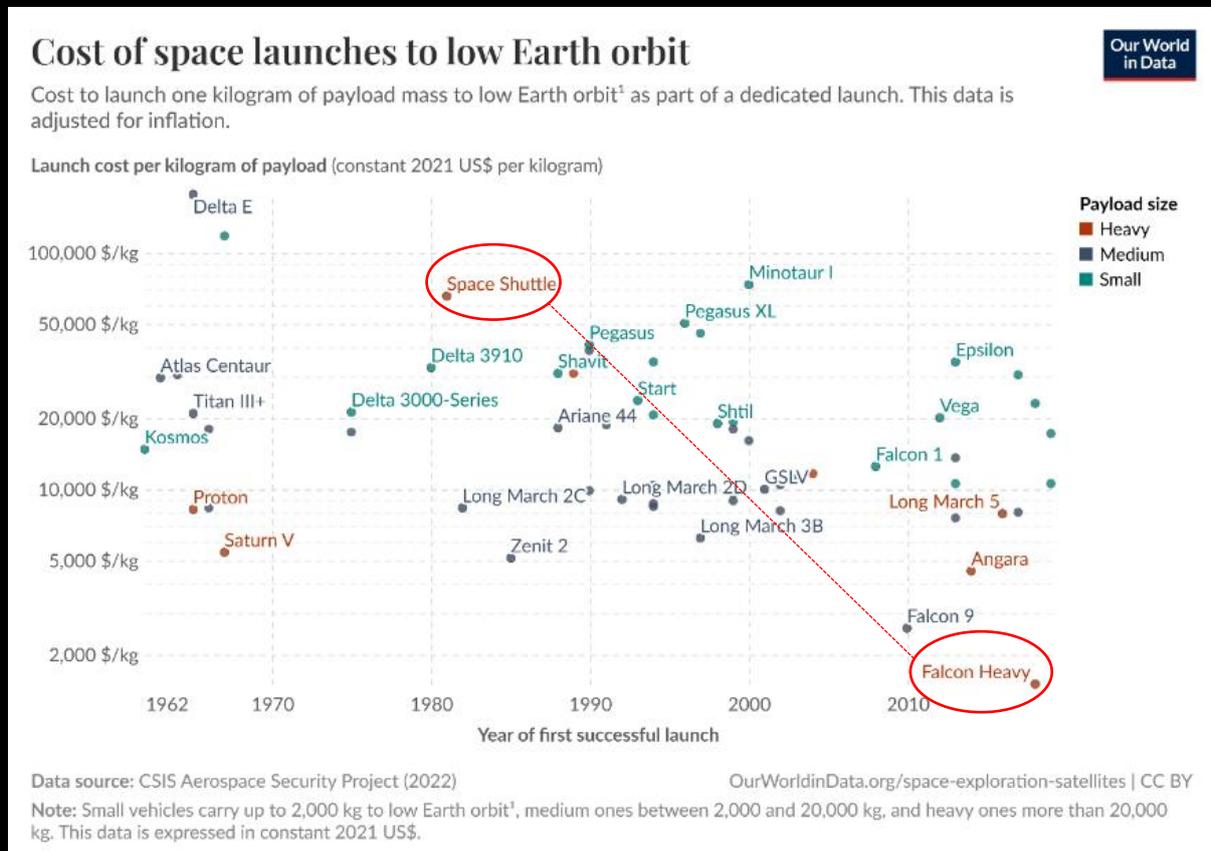
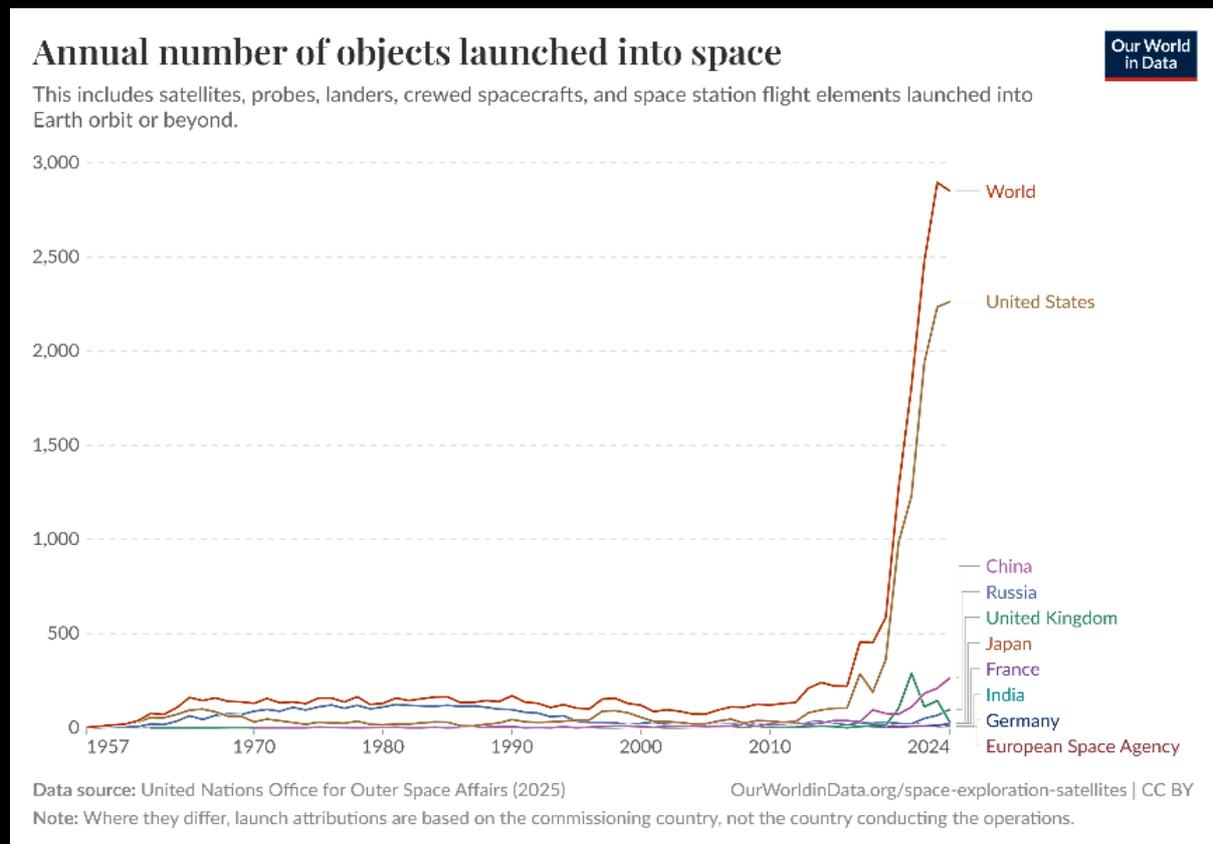


Chart: World in Data<sup>27</sup>

SpaceX fundamentally transformed the economics of space launch. Before its arrival, **sending a kilogram of payload to Low Earth Orbit (LEO) typically cost between \$10,000 and \$50,000** — as seen with vehicles like Ariane 44, Delta 3000 and the Space Shuttle.

With the advent of the partially reusable Falcon 9, **that figure dropped to around \$2,000 per kilogram**, and even lower with Falcon Heavy<sup>28</sup>. By proving that reusability was not only possible but commercially viable, **SpaceX** achieved what legacy contractors long dismissed. Its vertical integration — designing engines, structures and avionics in-house, while deploying its own satellite network through Starlink — further consolidated its cost advantage.

The McKinsey/WEF report<sup>29</sup> notes that the number of satellites launched per year has been growing at about 50% annually. This is verified by analysis conducted by Our World in Data.



Graph: Our World in Data<sup>30</sup>

## Key drivers of future growth

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Several structural trends support bullish forecasts:

1. **Falling costs and reusable technology:** launch costs have declined by an order of magnitude in two decades, enabling more payloads and new business models.
2. **Demand for connectivity and data:** satellite broadband and earth-observation data address underserved markets and support digital transformation in sectors like agriculture, logistics and finance. Communications, positioning, navigation & timing, and earth-observation services are expected to be major growth drivers. Novaspace<sup>31</sup> underscores that downstream services already represent more than half of the space economy's value.
3. **Government programmes and regulation:** defence spending on space is rising, with governments viewing space assets as strategic infrastructure. Space exploration programmes (e.g. NASA's Artemis, ESA's Moon missions), national and regional space-funding initiatives and regulatory reforms create demand and reduce barriers. Public procurement also underwrites private sector viability.
4. **Emergent opportunities:** long-term projections assume the development of new markets like in-orbit servicing, space manufacturing, lunar resource extraction and direct-to-device satellite communications. These markets remain speculative but hold significant upside if technical and regulatory hurdles are overcome.

## Risks and headwinds

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Despite optimism, several factors could cause the space economy to underperform the most bullish forecasts:

- **Capital intensity and funding cycles:** space ventures require large upfront investment. Private funding has declined after the 2021–22 peak. Access to capital will determine whether start-ups survive long enough to realise revenue and enter more mainstream investment universes.
- **Regulatory and sustainability challenges:** orbital congestion, radiofrequency spectrum allocation and environmental impacts may lead to stricter regulations, increasing costs. The lack of a global legal framework for activities such as debris removal or resource extraction introduces uncertainty.
- **Technological and execution risk:** many new business models (e.g. space-based manufacturing, lunar mining) depend on unproven technologies. Delays or failures could slow expected growth.
- **Macro-economic factors:** inflation, currency fluctuations and geopolitical tensions (e.g. national security restrictions) could dampen investment and demand.

Ultimately, the trajectory of the space economy will depend on whether cost reductions, technological breakthroughs and regulatory frameworks enable broad adoption of space-enabled solutions. Investors and policymakers should therefore scrutinise assumptions and definitions when comparing forecasts, while recognising that the underlying trend points to sustained expansion of a sector that is becoming integral to everyday life on Earth.

# SMALL & MIDCAP COMPANIES IN THE SPACE ECONOMY

## Where are smaller companies operating?

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Small & MidCap companies are active across every layer of the space economy, from manufacturing and launch to data analytics and downstream applications. They play a crucial role in enabling the larger ecosystem to function efficiently and sustainably.

Many are developing the technologies that make missions more cost-effective – from lightweight composite materials and advanced propulsion systems to reprogrammable payloads that extend the lifespan of satellites. Others specialise in in-orbit services such as debris removal, refuelling or recycling, helping to address the long-term sustainability of space operations.

Beyond orbit, smaller firms are central to the digital infrastructure that powers space-derived data. They design secure communications systems, develop cutting edge computing platforms and build software that accelerates the processing and transmission of data back to Earth.

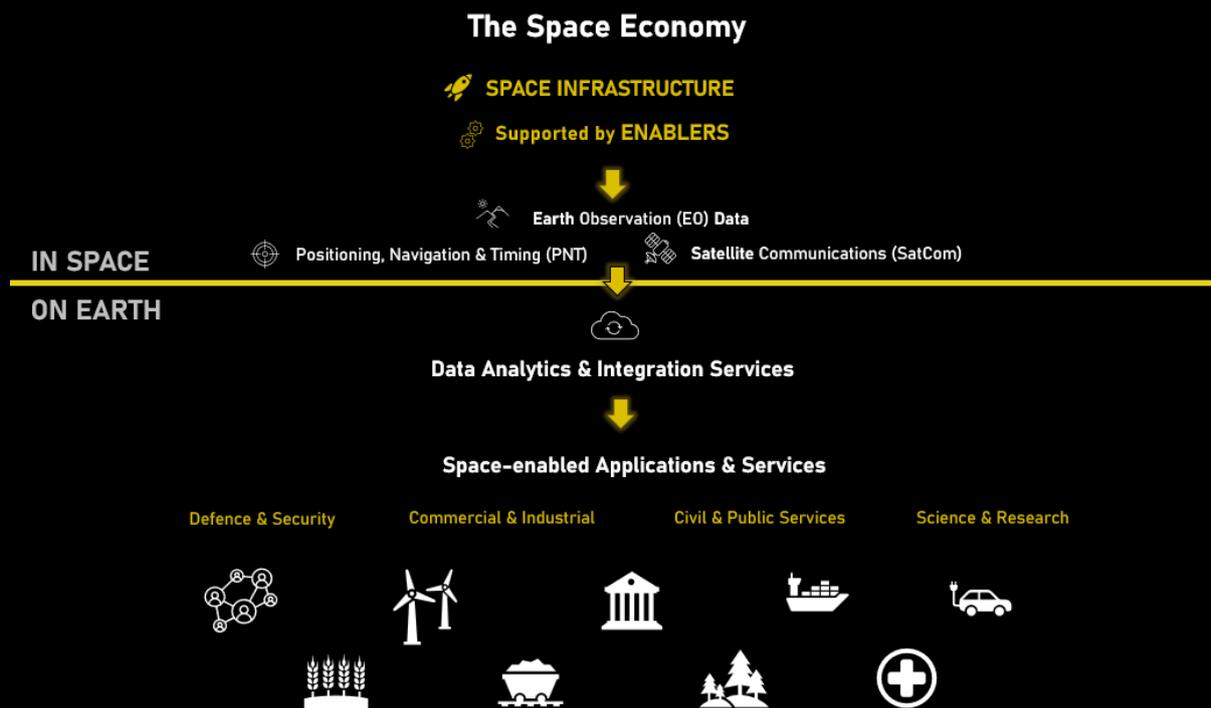
On the ground, Small & MidCaps also lead in analytics and geospatial intelligence, transforming raw satellite data into actionable insights for businesses and governments. Their tools enhance sectors as diverse as logistics, agriculture, energy management and defence intelligence.

Collectively, these companies demonstrate how smaller, specialist players are expanding the boundaries of what space technology can deliver – bridging the gap between physical infrastructure in orbit and real-world impact on Earth.

Selective exposure to quality Small & MidCap players can provide investors with a differentiated way to capture growth across this expanding ecosystem. The most attractive opportunities lie with companies that balance innovation with discipline – those delivering tangible technologies and services that underpin the space economy while avoiding the hype and volatility of more speculative ventures.

**The following diagrams show how different layers of the space economy connect and interact** — from the infrastructure that operates in orbit to the enablers, data systems and applications that translate this activity into value on Earth. Together, they provide a visual framework for understanding where Small & MidCap companies operate within the broader ecosystem, highlighting how their technologies and services link innovation in space with outcomes that matter on the ground.

## Mapping the Space Economy



Source: Montanaro AM. This diagram provides a simplified illustration of the space value chain to distinguish between in-space systems and on-Earth applications. In practice, several components – such as ground stations, mission control and data networks – operate across both domains.

Illustration: Montanaro AM

Earlier, we described the Space Economy in functional terms – dividing it into upstream, midstream, downstream, backbone and reach activities, consistent with how many analysts classify the sector.

The Space Economy can also be viewed through the value chain shown above – a visual framework that illustrates the interconnected system linking space infrastructure with the digital and terrestrial applications it enables. **Space infrastructure**, supported by **enablers** such as component suppliers and in-orbit servicing firms, underpins the three core data streams: **1) Earth Observation (EO); 2) Positioning, Navigation and Timing (PNT); and 3) Satellite Communications (SatCom)**.

These systems enable **Data Analytics & Integration Services**, which in turn support on-Earth, **Space-enabled Applications & Services** across four domains – **Defence & Security, Commercial & Industrial, Civil & Public Services** and **Science & Research**. Each domain can be further broken down into specific sectors such as energy, agriculture and logistics that already benefit, or are poised to benefit, from space-based technologies.

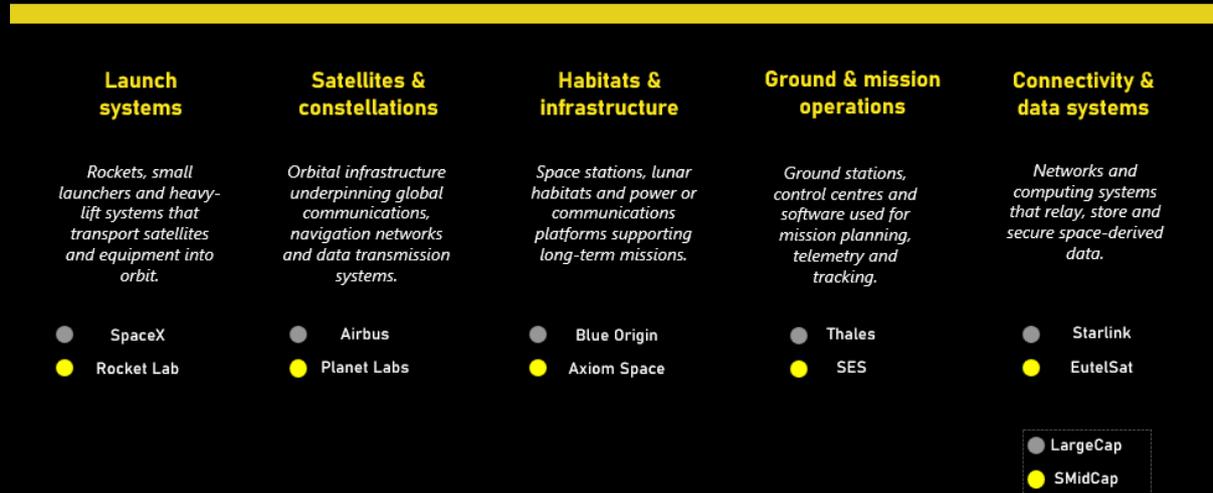
While the diagram distinguishes between in-space and on-Earth domains for simplicity, many components – including ground networks, mission control and data processing – operate seamlessly across both.

The following visual frameworks illustrate where Small & MidCap companies operate within the Space Economy, showing how their technologies bridge innovation in space with real-world impact on Earth.



## SPACE INFRASTRUCTURE

*(Build, launch and operate physical assets)*



Source: Montanaro AM. This diagram provides a simplified overview of in-space and on-Earth infrastructure. In practice, several systems — such as ground stations, mission control and communications networks — span both domains and support data transmission between orbit and Earth.

Illustration: Montanaro AM

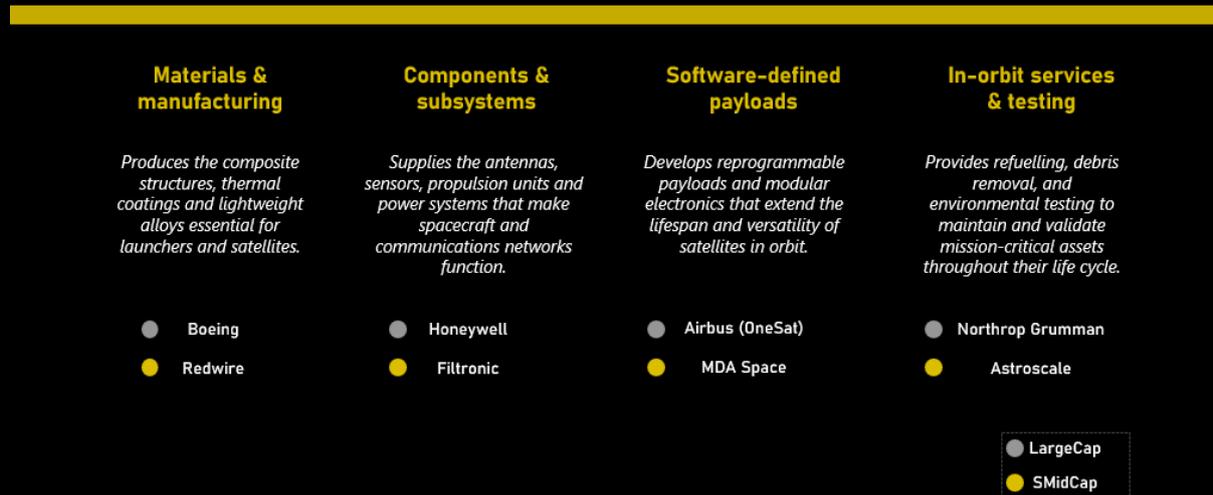
This chart shows the core structure of the Space Economy, capturing how assets are built, launched, operated and connected. The categories range from launch systems and in-orbit logistics, which deliver and maintain satellites, to habitats and infrastructure, which support longer-term missions and emerging commercial activity in orbit. These are complemented by ground and mission operations, responsible for controlling satellites and managing telemetry, and connectivity and data systems, which ensure secure communication and information flow between orbit and Earth.

Together, these elements form the operational backbone of the space economy. Both Large and Small & MidCap companies play vital roles across this system – from building and launching spacecraft to operating constellations and maintaining mission infrastructure. While firms such as **SpaceX** and **Airbus** lead large-scale launch and satellite operations, Small & MidCap companies like **Rocket Lab** and **Planet Labs** contribute across multiple areas, from launch and infrastructure to in-orbit services. Their innovation and responsiveness help to enhance the performance, sustainability and accessibility of space infrastructure, ensuring the ecosystem remains dynamic and resilient.



## ENABLERS

(Provide critical inputs, materials or servicing)



Source: Montanaro AM. This diagram provides a simplified view of the technologies that enable in-space systems. In practice, many enabler activities – from component testing to servicing – occur both pre-launch and increasingly in orbit.

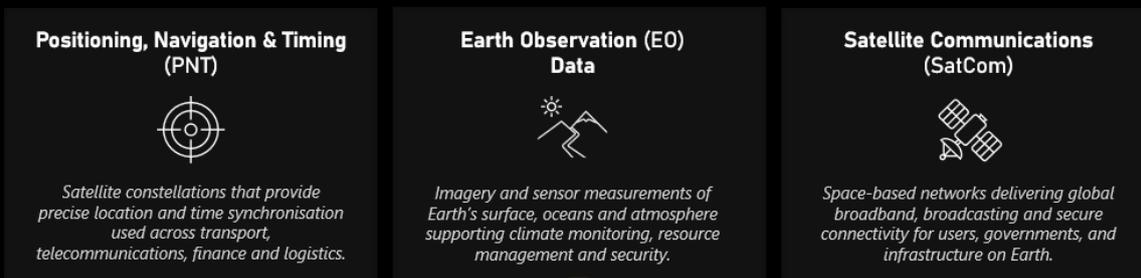
Illustration: Montanaro AM

The enablers are the technologies and services that make space infrastructure possible and sustain its operation. This includes producers of advanced materials and composites, suppliers of antennas, sensors and propulsion subsystems, and developers of software-defined hardware that can be updated or reconfigured in orbit. It also encompasses in-orbit servicing and testing, such as refuelling, debris removal and performance validation, which extend asset lifespans and reduce costs.

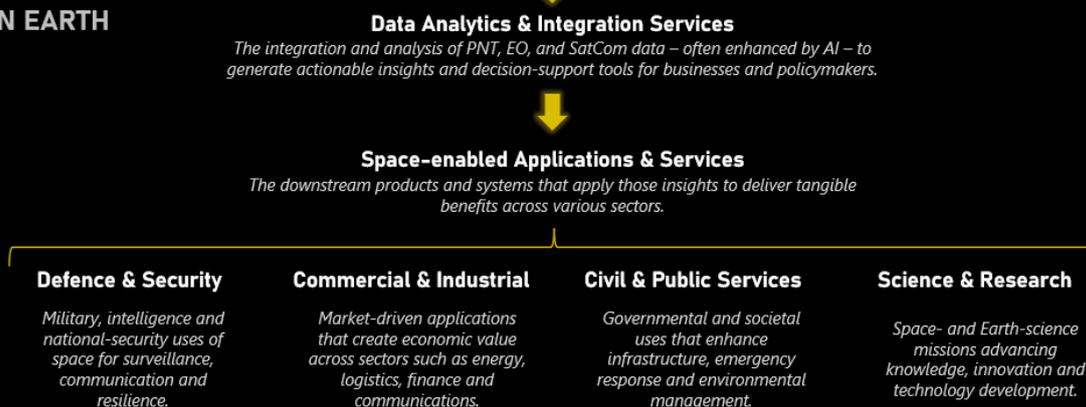
This is the layer where many Small & MidCap companies excel. They deliver the components and engineering solutions that larger firms depend on, often operating at the cutting edge of innovation. Examples include **Redwire's** structural and manufacturing technologies, **Filtronic's** high-frequency communications components, and **MDA Space's** adaptable satellite systems. These firms collectively provide the flexibility, precision and resilience that enable the wider space ecosystem to thrive.

## In-space and on-Earth systems

### IN SPACE



### ON EARTH



Source: Montanaro AM. This diagram focuses on downstream, space-enabled industries. In practice, many services rely on a continuous exchange of data with space infrastructure and cloud-based systems, blurring the boundary between in-orbit and terrestrial activities.

Illustration: Montanaro AM

This final chart illustrates how space infrastructure generates data that is transformed into value on Earth. In orbit, three key systems – **Positioning, Navigation & Timing (PNT)**, **Earth Observation (EO)** and **Satellite Communications (SatCom)** – produce the foundational data streams that underpin much of the modern economy. These are integrated through **Data Analytics & Integration Services**, often enhanced by AI, to produce insights for a wide range of on-Earth **Space-enabled Applications & Services**.

The resulting Space-enabled Applications & Services deliver impact across four domains: **Defence & Security**, **Commercial & Industrial**, **Civil & Public Services** and **Science & Research**. This flow from data capture in orbit to decision-making on Earth demonstrates how the space economy increasingly serves as an enabling layer for growth and innovation across industries.

While this diagram separates in-space and on-Earth systems for clarity, many processes – such as data transmission, storage and processing – occur seamlessly across both, with edge computing now taking place on satellites as well as on the ground.

## Space-enabled industries on Earth

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The **commercial opportunity** created by space infrastructure extends far beyond launch and satellite operations. The sector table on the following page illustrates how space-based data and technologies are **reshaping industries on Earth** – connecting and informing the global economy. Each sector reflects a distinct way that space can or could in future add value, from improving agricultural yields and energy efficiency to enhancing supply-chain visibility and supporting healthcare delivery in remote regions.

While many of these applications are still developing, their potential is significant. As satellites become more capable and launch costs continue to fall, the flow of space-derived insights into everyday decision-making will accelerate. For investors, this expansion offers exposure not only to core aerospace firms but also to **Small & MidCap** companies leading in digital communications, analytics and environmental monitoring – each helping to connect space technology with tangible outcomes on Earth.

*Please note that many of the companies cited operate across multiple sectors.*



“Nearly a fifth of our GDP is dependent on satellites”

**SIR CHRIS  
BRYANT,  
UK SPACE  
MINISTER**

Image: NASA, view of Great Britain and Ireland acquired aboard NASA’s Terra satellite<sup>32</sup>

Quote: UK Government<sup>33</sup>

Sector	Space-enabled use case	Company examples
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**Connectivity & Digital Inclusion**

Connectivity supports essential services, from education and telemedicine to online banking and e-commerce, and also enhances digital media, entertainment and social inclusion. Connected devices also enable critical safety functions such as emergency SOS communications.

Globalstar



Image: Unsplash, Thatched-roof huts<sup>34</sup>



**Agriculture & Forestry**

Using EO and sensor data to monitor crop health, optimise irrigation and detect drought or pest risk. EO improves food security by identifying replanting zones early, increasing yields and supporting forest monitoring for conservation and governance.

Planet Labs



Image: Unsplash, Green corn plant field<sup>35</sup>



**Energy & Utilities**

Space-based data improves performance and resilience by identifying optimal solar and wind-farm sites, monitoring vegetation near power lines and forecasting renewable output. It is also able to detect methane or oil leaks, and support grid management and emission reduction.

GHGSat



Image: Unsplash, Wind turbines<sup>36</sup>



### Mining & Natural Resources

EO supports mapping of mineral deposits and monitoring of tailings or emissions, while satellite links connect remote sites to headquarters for real-time coordination. Together, these tools improve operational efficiency, safety, regulatory compliance and environmental stewardship.

MDA Space



Image: Unsplash, A large truck driving down a dirt road<sup>37</sup>



### Insurance & Financial Services

Space-based imaging and analytics improve risk modelling, damage assessment and climate-related disclosure. EO data enables verification of claims, green mortgages and sustainability-linked lending. The dedicated space-insurance market – covering cyber, collision and debris risks – is forecast to grow from under \$1 billion (2023) to \$12 billion by 2035<sup>38</sup>.

ICEYE



Image: Shutterstock, Aerial view of London<sup>39</sup>



### Supply Chain & Transport

Space-enabled navigation and tracking improve global logistics efficiency. GPS, PNT and satellite IoT support real-time asset tracking and route optimisation across air, sea and land. EO enhances cold-chain monitoring for temperature-sensitive goods, while radio-frequency analytics track global cargo and maritime flows.

Globalstar



Image: Unsplash, Aerial photo of enclosed trailer<sup>40</sup>



### Aviation & Automotive

Today's mobility systems rely on space-derived positioning and connectivity. Satellites provide resilient in-flight connectivity and secure communications for commercial and defence aviation, enhancing navigation and safety. They also enable precise positioning for connected and autonomous vehicles.

Viasat



Image: Unsplash, An aeroplane flying in the sky at sunset<sup>41</sup>



### Health & Connectivity Services

Extending healthcare access through satellite connectivity. Telemedicine uses space-based communications for consultations, diagnostics and data exchange in remote or underserved areas, while satellite networks support mobile health units, emergency response and medical logistics where terrestrial links are limited.

Eutelsat



Image: Unsplash, Telemedicine<sup>42</sup>



### Climate, Sustainability & Humanitarian Services

Space technologies support global resilience and environmental management. Combining EO and SatCom enables real-time monitoring of carbon, methane and deforestation, helps detect illegal fishing in protected waters, and aids disaster response and humanitarian relief.

Planet Labs & MDA Space



Image: Unsplash, A pile of cut logs<sup>43</sup>

## Frontier applications – emerging industries in Space

While space-enabled sectors focus on applications improving life on Earth, a new wave of frontier activity is emerging in orbit. These ventures are building the foundations for future industries that could redefine manufacturing, travel and health research in microgravity.

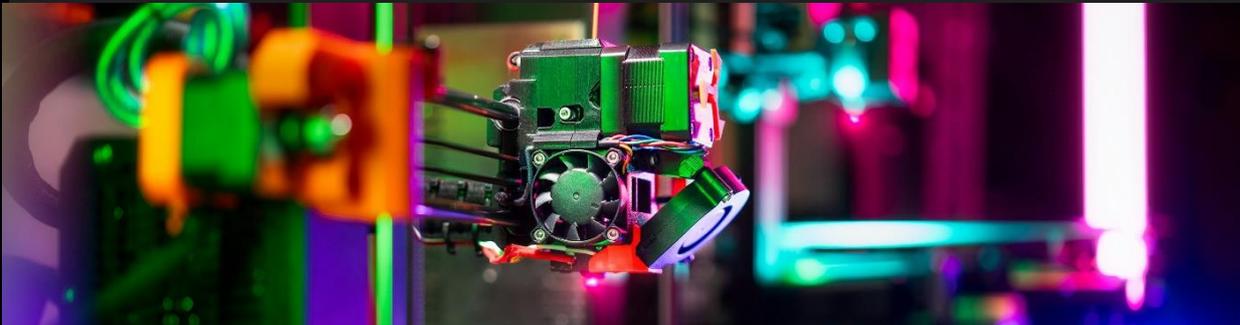
	Sector	In-Space use case	Company examples
	<b>Manufacturing &amp; Materials</b>	<p>In-orbit manufacturing is in early-stage demonstration but could become commercially viable within the next decade as launch costs fall and robotic assembly matures. Using microgravity and in-orbit R&amp;D, researchers are developing advanced materials, fibre optics and alloys impossible to produce on Earth, alongside semiconductor and robotics manufacturing to enhance precision and efficiency.</p>	<p>Redwire</p>
			
	<b>Tourism &amp; Emerging Space Ventures</b>	<p>Commercial ventures are beginning to extend human presence beyond Earth. Sub-orbital and orbital tourism, private stations and early manufacturing labs are becoming feasible as reusability drives down costs. These ventures mark the first steps toward permanent human and industrial activity in space.</p>	<p>Virgin Galactic</p>
			
	<b>Life Sciences &amp; Microgravity Research</b>	<p>Using microgravity to advance pharmaceutical research, cell growth and biomedical innovation. In-orbit laboratories could test new therapies and materials that behave differently in space, laying the foundation for future biomanufacturing and medical discovery beyond Earth.</p>	<p>BioOrbit</p>

Image: Unsplash, A close-up of a machine with lights in the background<sup>44</sup>

Image: Unsplash, Low-angle photography of red space shuttle<sup>45</sup>

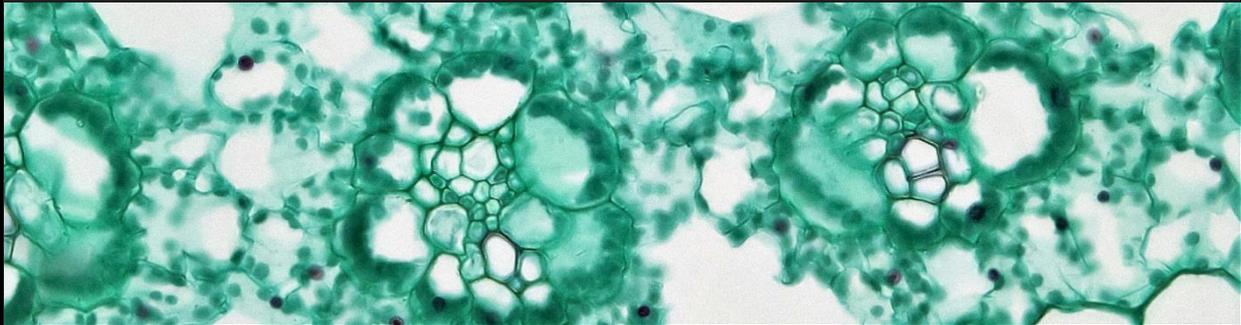


Image: Unsplash, Angiosperm morphology: substomatal chambers in Zea leaf cross section<sup>46</sup>



### Space-based Energy Systems

A new class of orbital solar power systems is being developed to harvest continuous sunlight in space and beam clean energy to Earth. Operating above weather and darkness, these satellites could generate power far more efficiently than ground-based solar farms, with emerging technologies using microwave beams for safe, long-distance transmission.

Space Solar



Image: Unsplash, Sunset view<sup>47</sup>



### In-orbit Data Systems

Companies are exploring satellites and modular platforms to host data centres in orbit. **SpaceX** plans to develop such systems through its next-generation Starlink network, processing information in space to reduce transmission delays and ease demand on Earth. This emerging approach is enabled by advances in high-speed data transfer, which are faster than traditional radio systems.

Archangel Lightworks



Image: Unsplash, Blue textile with red strap<sup>48</sup>

## Time to commercialisation

The following chart from Deloitte illustrates how different segments of the space economy are progressing towards commercial maturity. It highlights which technologies are already investible today and which remain longer-term opportunities that will depend on continued innovation, cost reductions and advances in launch capability.

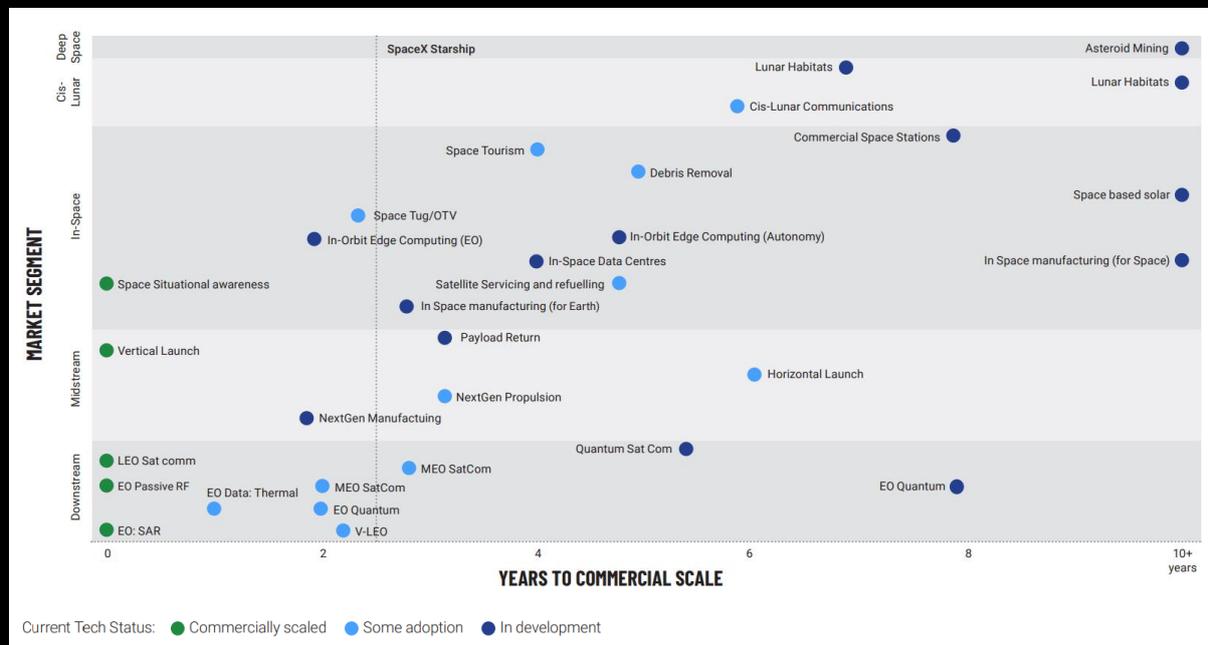


Chart: Deloitte<sup>49</sup>

**The near-term segment** (current): including satellite communications and Earth Observation – is already commercially scaled and investible today. These technologies underpin a range of applications in various sectors, offering recurring revenues and near-term growth potential.

**The emerging technologies segment** (mid-term, 2–5 years): covers technologies that are progressing from early demonstration to limited adoption, with broader scaling expected as launch costs continue to fall. Examples include space tourism and in-space manufacturing, which are now moving from proof-of-concept to early commercial contracts.

**The frontier segment** (longer term, 5–10 years): encompasses developments such as commercial space stations. These areas are advancing quickly but remain dependent on lower launch costs and reliable heavy-lift capacity to reach full commercialisation.

**The long-horizon segment** (10+ years): includes the most speculative but potentially transformative opportunities, such as space-based solar power, lunar habitats and asteroid mining. Progress here will rely on sustained innovation in transport, energy and autonomous systems.

The arrival of **SpaceX's Starship** marks a potential inflection point: once routine, reusable heavy-payload launch becomes feasible, it could dramatically accelerate commercial viability across these frontier and long-horizon areas.

# COMPANIES IN SPACE

## Quoted pioneers

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Small & MidCap companies are often the enablers of the space economy. They provide the components, technologies and specialist services that make large-scale missions and commercial applications possible. Yet this remains a highly speculative landscape. Many businesses are unproven, highly leveraged, or reliant on continual funding. A number are likely to fail before reaching sustainable profitability.

Montanaro's Quality Growth investment approach applies a rigorous filter to this universe. We look for companies with durable competitive advantages, such as defensible intellectual property, strong balance sheets and long-standing relationships with customers such as space agencies or defence contractors. Only those with established track records and differentiated capabilities are approved following detailed research. While few meet these standards today, the sector is increasingly giving rise to more businesses with high barriers to entry, repeat revenues and exposure to long-term structural investment themes — the qualities needed to compound value as the commercial space economy becomes a durable, multi-decade growth opportunity.

In the following pages we examine several short case studies of listed Small & MidCap businesses which operate within Montanaro's investible universe. Each plays a distinctive role within the space economy, providing commercially proven technologies that underpin satellite systems, in-orbit services and the digital infrastructure connecting Earth to space. Together, they illustrate how space is transitioning from a government-led endeavour to a sustainable, revenue-generating market for investors. Montanaro is currently an investor in some, but not all, of these companies.

*Please note that this list of companies is provided for information purposes only and does not constitute an investment recommendation.*



Image: NASA/ESA Hubble Space Telescope photo of the Sombrero galaxy, Messier 104 (M104)<sup>50</sup>

- Satellite systems, space robotics & mission hardware



Image: MDA, Canadarm2 on the International Space Station<sup>51</sup>

MDA Space is a Canadian-listed Small & MidCap company providing critical technologies across satellite systems, robotics and Earth observation. Founded in 1969, it has been central to Canada's space programme for over five decades and remains a global leader in mission hardware. The company combines advanced engineering and manufacturing with data and intelligence solutions that serve both government and commercial operators.

MDA is best known for the Canadarm robotic systems used on the Space Shuttle and International Space Station. It is now building Canadarm3 for NASA's Lunar Gateway (a space station that will orbit the Moon, part of the Artemis programme aiming to return humans to the lunar surface and ultimately support missions to Mars), extending its reach into deep-space infrastructure. Alongside robotics, MDA designs and manufactures high-performance satellite platforms, antennas and radar systems used in communications and Earth observation constellations.

Within the space economy, MDA Space operates primarily within space infrastructure, developing satellites, robotics and mission systems, while also acting as an enabler through technologies that support in-orbit operations and communications. Long-term contracts with the Canadian government, NASA and the European Space Agency and provide revenue visibility and credibility in a market often dominated by speculative ventures. With a diversified order book, proprietary technology and proven execution, MDA stands out as one of the few Small & MidCap space companies already operating at scale.

- Radio-frequency components, microwave technology & space communications



Image: Unsplash, a Starlink constellation travelling across the night sky<sup>52</sup>

Filtronic is a UK quoted Small & MidCap company specialising in high-performance radio-frequency, microwave and millimetre-wave technologies. Founded in 1977, it designs and manufactures advanced communications components used in satellite payloads, ground stations and defence systems. Its expertise in ultra-high-frequency signal processing enables faster, more reliable data exchange across both space and terrestrial networks.

Filtronic's technology plays a **critical role in connecting Earth to orbit**. The company develops and supplies high-performance radio-frequency amplifiers, transceivers and E-Band systems for leading satellite operators, **including a strategic partnership with SpaceX's Starlink programme on ground stations**. These systems support the expansion of large Low Earth Orbit (LEO) constellations that deliver high-speed internet connectivity across the globe. Filtronic's products are also used in next-generation connectivity initiatives for a European LEO constellation and the European Space Agency's secure satellite communications programmes.

From its cutting-edge UK and US facilities, Filtronic focuses on continuous Size, Weight and Power (SWaP) improvements — essential for modern space applications. Its ability to produce compact, energy-efficient systems **allows customers to scale their constellations faster and at lower cost**. The company's pioneering achievements **include developing the world's first 40 Gbps stratosphere-to-ground link and contributing to the first commercial E-Band earth station antenna**, technologies that are revolutionising 5G performance and low-latency satellite communications.

Within the space economy, Filtronic operates as an enabler, supplying critical hardware that connects satellites with terrestrial data networks. Its engineering depth, recurring contracts and partnerships with global leaders such as **SpaceX** position it as **one of the few UK-listed Small & MidCap companies with an established, profitable foothold in the commercial space ecosystem**.

- Defence technology, electronic systems & cyber solutions



Image: Unsplash, A large boat in the middle of the ocean<sup>53</sup>

Cohort is a UK quoted Small & MidCap defence and technology group providing advanced systems and services for national security, intelligence and communications. Established in 2006, the company operates as a federation of specialist businesses with **complementary expertise across defence, aerospace and space**. Its diversified model enables Cohort to combine innovation in electronic warfare, surveillance and secure communications with long-standing customer relationships across NATO and allied nations.

Through its subsidiary EM Solutions, acquired in early 2025, Cohort is expanding its presence in the **space domain**. EM Solutions designs and manufactures high-performance satellite communication systems that enhance situational awareness for maritime and defence clients. **These technologies support resilient, high-bandwidth connectivity across remote operations — an increasingly critical capability as space-based communications and intelligence become central to modern defence strategy.**

Within the space economy, Cohort operates as an enabler, providing advanced defence and communications technologies that support satellite operations, secure data transmission and **situational awareness**. Its naval specialisation offers a distinctive strategic advantage at a time when many countries have focused primarily on aerial capabilities, leaving maritime systems underinvested. The one exception — China's sustained naval build-up — has prompted renewed **regional investment in advanced naval and space-linked communications solutions, benefiting Cohort's core markets.**

With a proven track record in delivering mission-critical systems, Cohort is **well positioned to capture growing demand for integrated space and defence technologies** in an increasingly contested global environment.

- Rocket propulsion & space launch systems

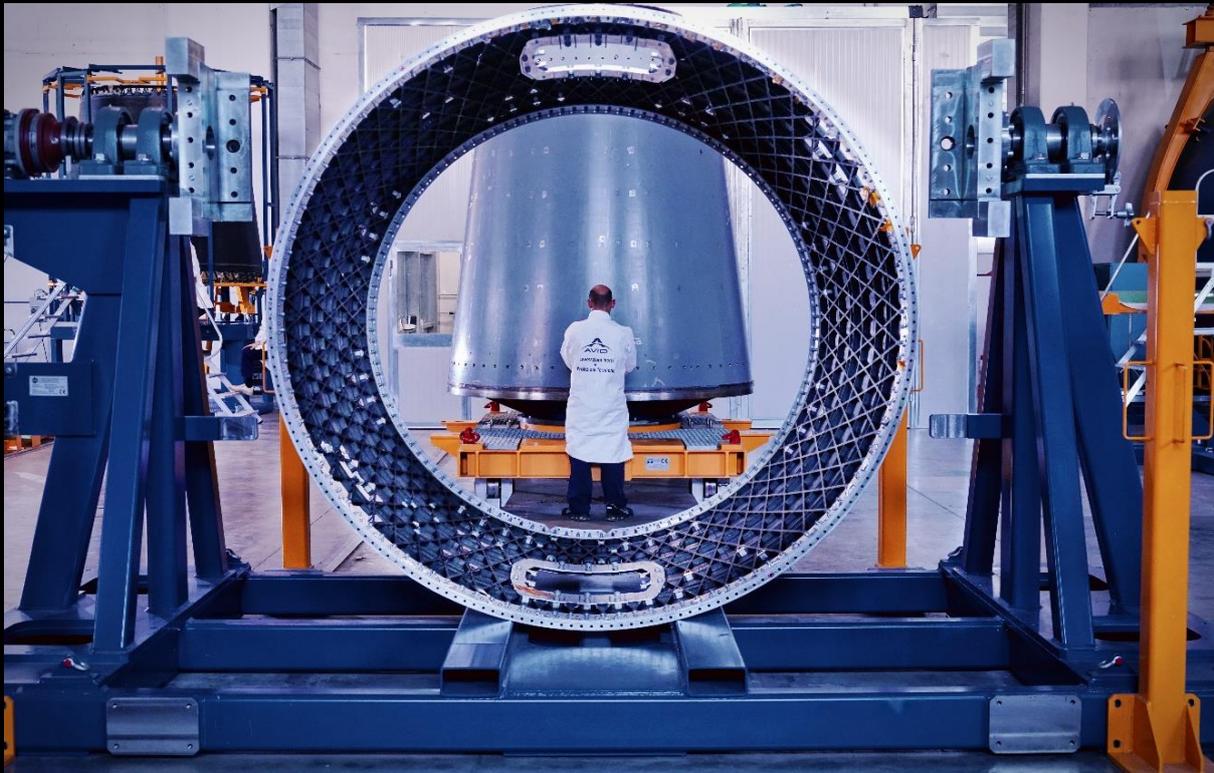


Image: Avio manufacturing site, Colferro, Rome, Italy<sup>54</sup>

Avio is an Italian-listed Small & MidCap company and one of Europe's few pure-play launch providers. Founded in 1908 and headquartered near Rome, the company designs and manufactures solid-propellant rocket motors and complete launch systems for the European Space Agency. It serves as **the prime contractor for the Vega and Vega-C launchers** and a major propulsion supplier for the Ariane 6 heavy-lift vehicle, making it central to Europe's independent access to space.

Avio's engineering strength lies in solid propulsion and system integration. Its P120C booster powers both Vega-C and Ariane 6, offering economies of scale, cost stability and reliability. Production and integration are carried out in Italy and at the Guiana Space Centre in Kourou, French Guiana, from where Vega launches take place. **This dual role — as launcher developer and service provider — gives Avio recurring institutional revenue visibility through long-term ESA and national agency contracts.**

The launch business remains high-risk. **Each mission is a visible binary event:** success builds reputation, while failure can delay programmes and strain cash flow. Vega-C's 2022 anomaly highlighted this vulnerability, leading to design reviews and flight stand-downs. Meanwhile, competition from **SpaceX, Rocket Lab** and India's PSLV, and the rise of reusable systems, challenge the long-term viability of solid-fuel vehicles.

**Within the space economy, Avio operates within space infrastructure, designing and manufacturing launch vehicles and propulsion systems that enable satellite deployment and access to orbit.** With a strong order backlog, cost synergies from the P120C programme and renewed confidence following Vega-C's return to flight, **Avio remains Europe's cornerstone launch specialist — albeit in one of the most technically demanding and financially volatile segments of the Space Economy.**

- Space debris removal, satellite servicing & orbital sustainability

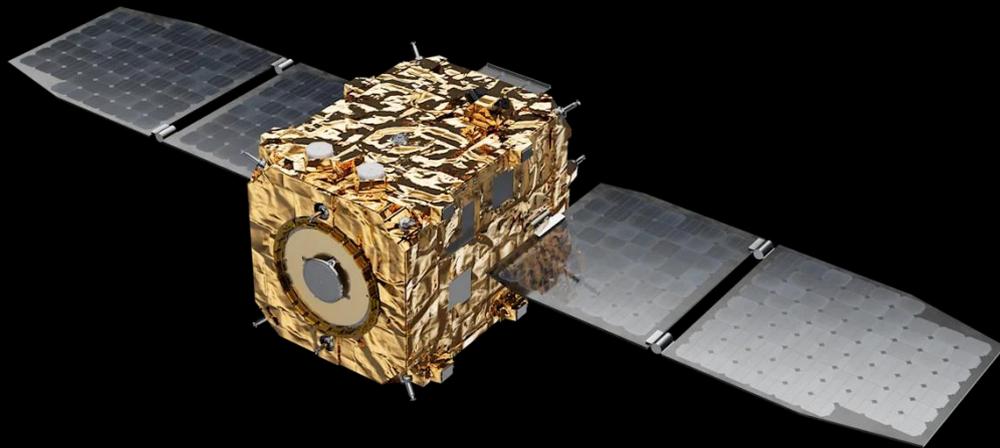


Image: Astroscale, Active debris removal satellite<sup>55</sup>

Astroscale is a Japanese-listed Small & MidCap company pioneering in-orbit servicing and space sustainability. Founded in 2013, it develops technologies that enable the safe removal, refuelling or repositioning of satellites to **tackle the growing problem of orbital debris**. Headquartered in Tokyo with subsidiaries in the UK, US and Singapore, **Astroscale’s mission is to ensure space remains a sustainable domain for future generations**.

Its proprietary docking and guidance technologies combine autonomous navigation with precision capture systems. **The ELSA-d mission successfully demonstrated magnetic rendezvous and capture capabilities in orbit — a key milestone for the commercial viability of end-of-life satellite management**. The mission involved two small spacecraft — a “servicer” and a “client” — launched together to test whether one satellite could locate, approach and capture another in orbit using magnetic docking technology. In doing so, **Astroscale became the first non-governmental company to demonstrate this capability in space**. The mission proved that satellites could be safely retrieved or repositioned at the end of their operational life, a key milestone for the commercial viability of debris removal and in-orbit servicing.

Building on this success, Astroscale’s follow-on missions include ADRAS-J (Active Debris Removal by Astroscale-Japan), developed in collaboration with JAXA, Japan’s national space agency. **ADRAS-J aims to locate and inspect an actual piece of space debris left by a Japanese rocket, paving the way for future missions that will physically capture and de-orbit defunct satellites**. Together, these missions advance Astroscale’s goal of making orbital clean-up and satellite servicing a practical, repeatable part of the space economy.

Within the space economy, Astroscale operates as an enabler, developing in-orbit servicing and debris removal technologies that extend the life of physical infrastructure and reduce collision risk to support the sustainable use of orbital environments. **Its early-mover advantage, regulatory alignment and expanding global partnerships position it as a strategically important Small & MidCap company in the fast-developing field of orbital sustainability**.

- Earth imaging, satellite data & geospatial analytics

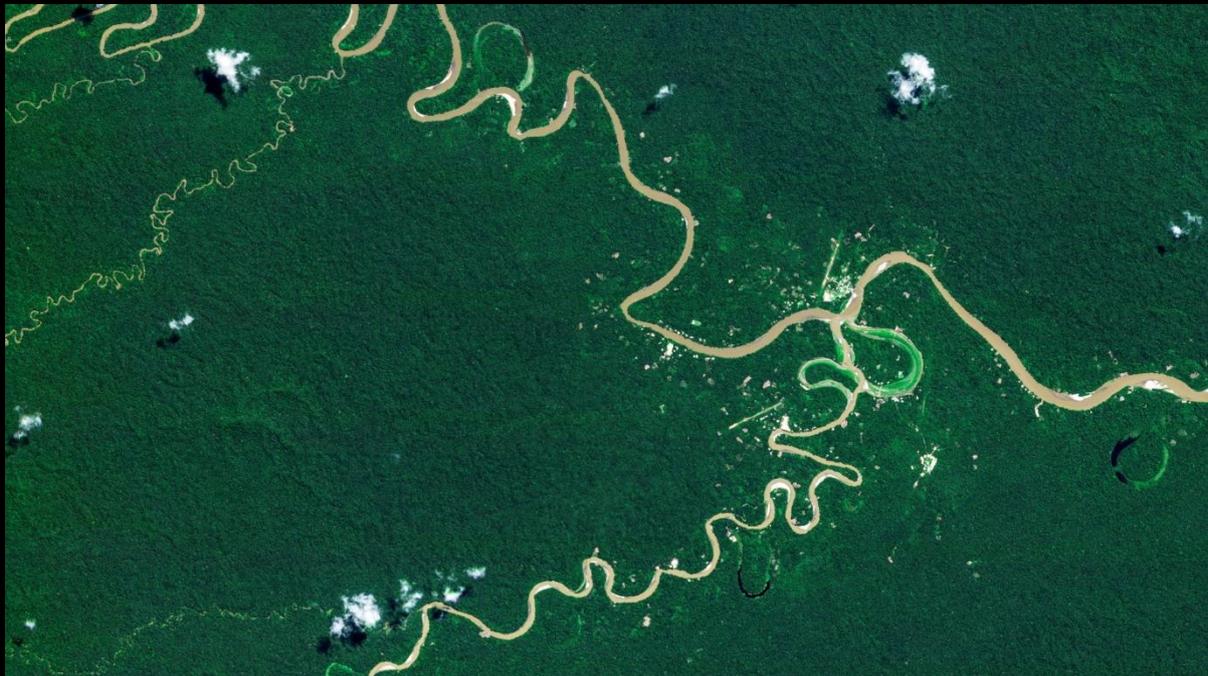


Image: Planet Labs, Satellite image of rainforest region<sup>56</sup>

Planet Labs is a US listed Small & MidCap company operating the world's largest fleet of Earth Observation satellites. Founded in 2010 by former NASA engineers Will Marshall, Robbie Schingler and Chris Boshuizen, the company set out to “democratise access to Earth data”<sup>57</sup> by imaging the entire planet every day. Headquartered in San Francisco, Planet Labs now operates over 450 small satellites in Low Earth Orbit (LEO), capturing medium-resolution images that are processed and delivered through its cloud-based analytics platform. These data are used across agriculture, forestry, energy, insurance and government sectors to monitor environmental change, assess risk and enhance decision-making.

In *When the Heavens Went on Sale*, Marshall is described as “a philosopher-engineer who wanted to turn space into a shared mirror for the Earth”<sup>58</sup> capturing humanity's footprint in near real time. That ambition underpins Planet's mission today: converting vast quantities of orbital imagery into actionable insight. Rather than selling hardware, Planet monetises its data through subscription-based access, offering time-stamped, objective intelligence on everything from deforestation and crop yields to infrastructure development and disaster response.

Within the space economy, Planet Labs operates within space infrastructure, deploying and managing constellations of Earth Observation satellites that capture high-resolution imagery to support environmental monitoring and data-driven decision-making on Earth. While competition and high data-processing costs continue to pressure margins, Planet's scale, recurring-revenue model and integration with AI analytics make it the clear market leader in commercial Earth Observation — and one of the most tangible examples of Will Marshall's original vision: to make the entire planet observable, accountable and ultimately, more sustainable.

## Emerging innovators

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The following companies operate in the private markets, where Montanaro does not invest. We monitor developments in this space closely to understand how breakthrough technologies, business models and early-stage ventures may shape our future investible universe. These innovators highlight the cutting edge of the space economy – from microgravity biotechnology to orbital energy generation and next-generation communications – offering insight into what may become tomorrow’s listed opportunities.

### GHGSat

Canada

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- Greenhouse gas monitoring, satellite data & emissions tracking



Image: GHGSat, GHGSat-C10 “Vanguard”, the world’s first commercial high-resolution CO<sub>2</sub> sensor<sup>59</sup>

GHGSat is a Canadian-based private company operating a constellation of satellites dedicated to monitoring greenhouse gas emissions from industrial and natural sources. Founded in 2011 and headquartered in Montreal, it provides high-resolution, independent data on methane and carbon dioxide emissions to clients across energy, mining and finance. **Its unique capability lies in detecting methane emissions down to individual facilities** – a precision unmatched by public Earth Observation programmes.

GHGSat combines proprietary satellite sensors with advanced analytics and machine learning to deliver near-real-time environmental intelligence. With over a dozen satellites in orbit and more launches planned, its data are used to verify emissions reductions, support climate disclosures and monitor regulatory compliance.

Within the space economy, GHGSat operates within space infrastructure, using satellite-based sensors to monitor greenhouse gas emissions and provide high-resolution data for industrial and environmental applications. Its work directly supports SDG 13 (Climate Action) and SDG 9 (Industry, Innovation and Infrastructure). As demand for verified emissions data intensifies, GHGSat’s proven technology, commercial customer base and growing fleet make it a clear example of a space-enabled company delivering measurable environmental and financial value.

- Microgravity biotechnology, space-manufactured protein crystals & pharmaceuticals

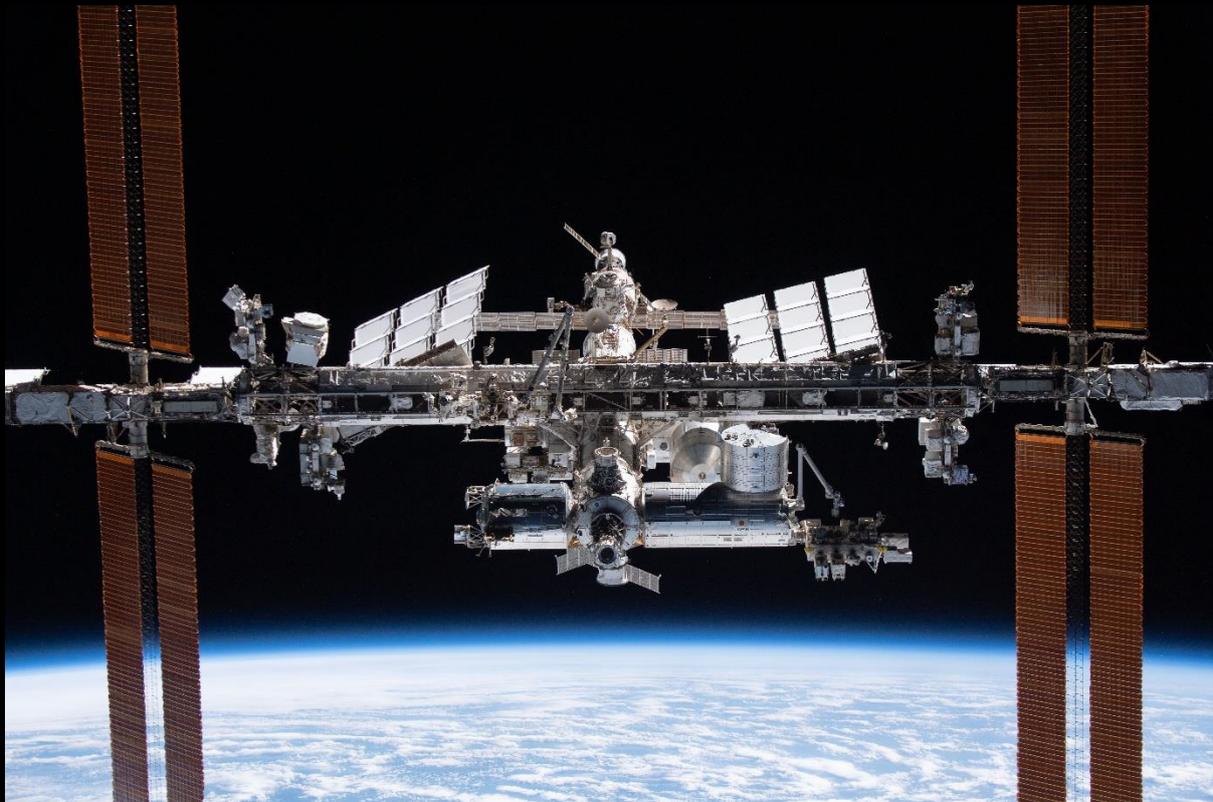


Image: NASA, The International Space Station, November 2021<sup>60</sup>

BioOrbit, an early-stage private company, has an impressive mission: it is aiming to be the go-to pharmaceuticals factory in microgravity. It seeks to harness the unique conditions of space — near-zero gravity and radiation exposure — to accelerate innovation in pharmaceuticals, cell biology and materials science. By building orbital research platforms, BioOrbit supports growing demand for space-based R&D in drug crystallisation, cell growth and protein folding.

The company provides access to microgravity laboratories and data analytics tools for public and private research partners. **Experiments in these environments can reveal molecular behaviours impossible to observe on Earth**, with potential breakthroughs in drug formulation, tissue regeneration and biomaterials.

Within the space economy, BioOrbit operates within space infrastructure, developing satellite payloads and platforms designed for biological and life science research in microgravity environments. It builds the platforms that host biological experiments while providing the analytical tools that commercialise their results. Though still early-stage, **BioOrbit reflects a broader trend of applying space capabilities to human health and industrial innovation** – suggesting biotechnology may become one of the next frontiers of commercial space activity.

- Space-based solar power, orbital energy systems & transmission technology



Image: Space Solar, HARRIER 360-degree power beaming technology demonstrator<sup>61</sup>

Space Solar is a UK-based private company developing technology to generate renewable energy in orbit and beam it to Earth via microwave transmission. Its concept involves deploying large solar arrays in geostationary orbit to collect uninterrupted sunlight and transmit power to ground receivers – providing a continuous, zero-carbon energy source that complements terrestrial renewables.

The company is conducting feasibility studies and engineering development with partners across academia, industry and the UK Space Agency. Space Solar estimates that the first operational system could be deployed within twelve years, combining advances in lightweight materials, wireless power transfer and modular satellite assembly.

Within the space economy, Space Solar operates primarily within space infrastructure, developing orbital solar power stations to collect and transmit renewable energy, while also acting as an enabler through its wireless power transmission and in-orbit assembly technologies. **While commercialisation remains over a decade away, it is among the most ambitious clean-energy projects under development.**

- Satellite servicing, space debris removal & orbital transport



Image: Starfish Space, "Otter Pup" small servicing vehicle for satellite extension and disposal<sup>62</sup>

Starfish Space is a US-based private company developing autonomous spacecraft designed to **service, reposition and eventually remove satellites in orbit**. Founded in 2019 by former **Blue Origin** engineers, the company is building the "Otter" series of servicer vehicles — small, agile spacecraft capable of rendezvous and magnetic docking with client satellites. By enabling in-orbit repairs, refuelling and controlled de-orbiting, Starfish aims to extend the lifespan of satellites and reduce orbital debris, a growing sustainability challenge for the space industry.

The company's first demonstration mission, Otter Pup, launched in 2023 and validated key autonomous navigation and capture systems in Low Earth Orbit (LEO). Supported by NASA and the US Space Force, Starfish has since secured contracts for follow-on missions that will test full docking and servicing capabilities. **Its modular architecture allows the same platform to be adapted for life-extension, relocation, or de-orbit services, creating a potential new class of "tow trucks" in space.**

Within the space economy, Starfish Space operates as an enabler, developing in-orbit servicing, debris removal and docking technologies that enable satellite capture, relocation and life-extension to support the long-term sustainability of orbital infrastructure. While technical complexity and mission risk remain high, the company benefits from institutional backing and a first-mover position in the emerging market for on-orbit servicing and space logistics — **a critical step toward a more circular and sustainable space ecosystem.**

- Laser communications, optical data transfer & space connectivity



Image: NASA, Laser beam communications are more efficient, more secure and more flexible<sup>63</sup>

Archangel Lightworks is a UK-based private company developing high-speed laser communication systems that transform how data are transmitted between satellites and Earth. Its optical laser technology replaces traditional radio frequency links, enabling far greater data throughput with enhanced security and lower latency. By focusing on portable, rapidly deployable optical ground stations, Archangel aims to make high-bandwidth space communications more flexible and scalable.

**Its systems are designed to serve the surging data demands of satellite constellations**, Earth Observation networks and in-orbit processing. Laser communications offer reduced interference, stronger encryption and higher speeds — essential for commercial and defence applications alike. The company has already demonstrated world-leading performance in rapid-deployment optical links with UK and European partners.

Within the space economy, Archangel Lightworks operates as an enabler, developing high-capacity laser communication systems that enable rapid data transfer between satellites and ground networks. Its innovations underpin the trend toward real-time, integrated connectivity between orbit and Earth. Though early in its commercial journey, **Archangel exemplifies the new generation of UK space innovators developing the communications backbone for a truly connected space-to-Earth data ecosystem.**

# SUSTAINABILITY IN SPACE

The concept of “sustainability in space” requires some definition. It refers both to the long-term viability of Earth’s immediate orbital environment and to the contribution of space technology to sustainable development on Earth, and indeed beyond.

As with most things “sustainable”, these are two sides to the same coin. Investors must weigh up this tension when considering how to allocate capital: exploiting space for Earth’s benefit and humanities future, while preserving space as a domain for future generations.

## Arguments against human space activity

Let’s get the bad out of the way first. The main sustainability concerns regarding space are as follows:

### Orbital congestion and space debris

The Secure World Foundation<sup>64</sup> notes that, as of February 2025, more than 11,400 active satellites orbit Earth, providing social, scientific and security benefits, yet the orbital environment is a finite resource and is threatened by proliferating space debris and congestion<sup>65</sup>.

The exponential increase in satellite launches has crowded Low Earth Orbit (LEO). Analysis from *Via Satellite*<sup>66</sup> notes that between 2013 and 2023 the number of annual satellite deployments grew twelve times to over 2,600 per year, mostly driven by megaconstellations such as Starlink and **OneWeb**.

The European Space Agency’s 2025 space environment report warns that Earth’s orbital environment is finite; active satellites share space with large quantities of debris, including more than 20,000 pieces larger than 10 cm and an estimated 850,000 fragments between 1 cm and 10 cm. These objects pose collision risks that could trigger the Kessler syndrome, a chain reaction of debris that renders orbits unusable<sup>67</sup>. Compliance with debris-mitigation guidelines remains inadequate. In 2022, only 55% of satellites and 85% of rocket bodies adhered to post-mission disposal guidelines<sup>68</sup>.

This is why a company like [LeoLabs](#) exists: providing real-time orbital Intelligence for space domain awareness and space traffic management. The highways of space are already busy:

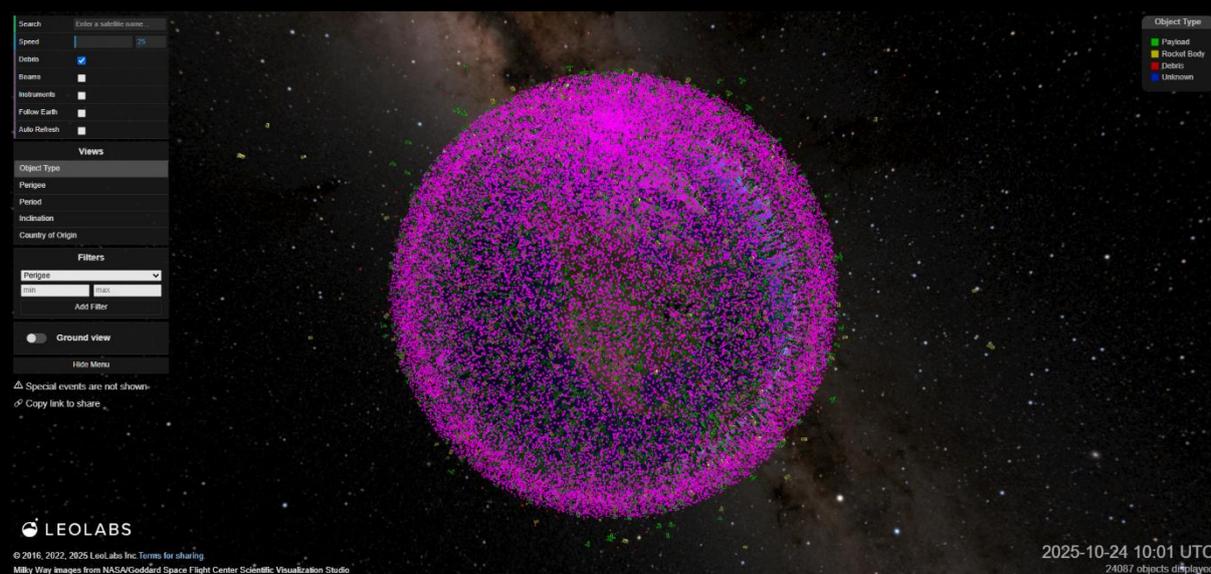


Image: LeoLabs, Low Earth Orbit Visualisation (LEOV) screen tracking every item in LEO<sup>69</sup>

ESA's report notes that major fragmentation events in 2024 added thousands of new debris objects and that intact satellites or rocket bodies re-enter Earth's atmosphere more than three times per day. Without active debris removal, the number of objects will continue to grow even if launches stop. Long-term sustainability therefore depends on stringent space traffic management and debris removal programmes<sup>70</sup>.

### Environmental impacts of rocket launches and re-entry:

- **Carbon emissions:** Although rocket launches currently contribute a tiny fraction of global carbon emissions, their environmental impact could grow. The Inverse analysis cites calculations showing that rocket launches accounted for only 0.0000059 % of global carbon emissions in 2018<sup>71</sup>, compared with global aviation's 2.4% share of carbon emissions. A 2024 study by academics at Glasgow Caledonian University estimated that a Starship launch produces 76,000 metric tons of CO<sub>2</sub>e, 2.7 times the emissions of a Falcon 9 launch; however, Starship's large payload means its emissions per ton to orbit are similar to the Falcon 9<sup>72</sup>. Elon Musk and supporters argue that rocket emissions are negligible compared with other sectors and note that Starship uses liquid methane, which emits less carbon per unit of payload than kerosene. CleanTechnica observes that total spaceflight emissions are several orders of magnitude less than those from agriculture (~24%) or energy production (~25%)<sup>73</sup>. **SpaceX** plans to produce methane fuel by capturing CO<sub>2</sub> from the atmosphere and combining it with hydrogen using the Sabatier process, aiming for a carbon-neutral fuel cycle. Critics counter that methane combustion still produces carbon dioxide and water vapour, both greenhouse gases, and that carbon capture will require substantial energy.
- **Soot and other pollutants:** Scientists highlight black carbon (soot) and other exhaust components as more problematic than CO<sub>2</sub>. Rocket engines burning kerosene or synthetic rubber emit black carbon particles that accumulate in the stratosphere, absorbing sunlight and warming the atmosphere. Aerospace America reports that the climate impact of rockets' CO<sub>2</sub> emissions is negligible, yet black carbon remains a major concern because it can linger for three to five years in the stratosphere. These particles may disrupt weather patterns by altering heat distribution and may accelerate ozone-depleting chemical reactions<sup>74</sup>. Rocket exhaust contains reactive nitrogen oxides, chlorine and alumina (from solid rocket motors), which can deplete the stratospheric ozone layer. A 2024 modelling study cited by Mongabay projected that if launches increase tenfold to about 2,040 per year by 2030, global stratospheric ozone could fall by around 0.29 %, with a 3.9 % depletion over Antarctica<sup>75</sup>.
- **Re-entry emissions and "space junk burn-up":** Re-entering satellites and rocket stages burn up in the upper atmosphere, releasing metallic particles and other compounds. Researchers note that re-entry emissions will soon exceed what scientists terms the natural meteoritic influx (meaning human-made re-entries may now deposit more material into the upper atmosphere than incoming space dust itself). Satellites burning up have increased from a few tonnes per year to a few tonnes per day. Metal oxides and other aerosols may catalyse ozone depletion. These impacts are poorly understood, underscoring the need for further research and regulatory oversight<sup>76</sup>.

### Light pollution from large satellite constellations

The increasing number of Low Earth Orbit (LEO) satellites, particularly from megaconstellations such as **SpaceX's** Starlink, has led to a noticeable rise in the number of bright, moving objects visible in the night sky. A 2023 study in *Nature Astronomy*<sup>77</sup> estimated that these satellites could double the brightness of the night sky in some regions, reducing the sensitivity of ground-based telescopes and hindering

observations of faint celestial objects. The International Astronomical Union (IAU)<sup>78</sup> has warned that even relatively dim satellites can interfere with long-exposure astrophotography and radio astronomy. In response to criticism, operators such as **SpaceX** have experimented with non-reflective coatings and darker paint materials – “DarkSat” and “VisorSat” designs – to reduce albedo and glare. Early tests reported brightness reductions of 50–60%<sup>79</sup>, but researchers note that cumulative effects from tens of thousands of satellites still pose significant challenges for both professional and amateur astronomers.

### Supply chain, ground infrastructure and launch sites

The environmental footprint of the space sector extends beyond launches. Mongabay reports that the industry’s supply chain requires large quantities of metals, critical minerals and water, and that energy-hungry data storage supporting satellites emits carbon equivalent to 41,000 London-to-Paris flights per year. Launch sites often occupy sensitive ecosystems; 60 % of launch facilities overlap with protected areas, especially tropical coastal zones. Noise, water pollution and debris can threaten local wildlife, as seen in concerns over sea turtle nesting beaches and mangroves. Conservation groups highlight that environmental assessments often underestimate these risks and call for more rigorous reviews.

### Resilience and dependence on space infrastructure

While satellites enhance sustainability, they also create new vulnerabilities. Minna Palmroth, a space physicist, and Janne I. Hukkinen, a sustainability scientist – both at the University of Helsinki – argue that green and digital infrastructures are tightly coupled to satellite services, making them vulnerable to extreme space-weather events such as solar storms<sup>80</sup>. A severe geomagnetic storm could disrupt satellite communications, navigation and power grids, threatening the very sustainability transition satellites are meant to enable. The authors call for resilience-based strategies, including improved space-weather forecasting and diversified infrastructure.

### Ethical concerns

The rapid commercialisation of space raises questions about equitable access and environmental justice. The expansion of space tourism, which caters largely to wealthy individuals, has been criticised as an inequitable use of planetary resources. Some researchers call for regulatory frameworks that consider not just environmental impacts but also social equity. Some “space” companies also supply technologies to defence or surveillance sectors, raising further questions for ethically minded investors.

There is also the question of ownership. What would it mean for humanity if a private company, say, was the first to land on another planet. In his biography of Elon Musk, Walter Isaacson recounts, “*every week, amid the engine and rocket design reviews, [Musk] held a meeting called Mars Colonizer, where he and the team discussed what a settlement on Mars would look like and how it should be governed.*”<sup>81</sup>

The fact that such questions were explored inside a private company, rather than in intergovernmental or academic forums, has material implications. It raises the prospect that the first off-Earth, self-sustaining settlement could be shaped primarily by the priorities, governance norms and resource allocation decisions of the corporate entity that enables it. For investors, the question is not only whether Mars becomes viable, but who defines the rules. As we grapple with undue governmental influence across on earth politics from wealthy billionaires in the private sector, how might we cope if such problems extend across the cosmos?

To end of a positive note, however, how can we learn from the problems humanity has experienced on earth and do better when humans, as we must anticipate, do become multiplanetary – perhaps even in many of our own lifetimes.

## The benefits of humanity in space

In light of these challenges, to what extent do the benefits of human activity in space justify allocating significant resources away from Earth towards space exploration and technology?

The main sustainability reasons in favour of human activity in space include:

### Sustainable development on Earth

Space infrastructure is central to modern sustainability goals. Earth Observation satellites enable real-time monitoring of climate-related variables such as deforestation, polar ice extent, crop health and greenhouse-gas emissions, as we have seen with companies like **Planet Labs**. The Space for Climate Observatory<sup>82</sup> is an international organisation using satellite data to help nations prepare for extreme weather. Such data underpin early-warning systems for hurricanes, floods and wildfires, reducing loss of life and property and supporting the UN Sendai Framework for disaster risk reduction. Precision agriculture uses satellite imagery to optimise fertiliser and water use, supporting SDG 2 (Zero Hunger). Satellites also aid natural resource management by tracking illegal fishing and monitoring forest cover, thereby supporting marine and terrestrial biodiversity, examples of which **MDA Space** is involved in.



Space for Climate Observatory, Global projects map<sup>83</sup>

### Connectivity

Connectivity is another major benefit. Satellite broadband brings internet access, telemedicine and remote education to underserved regions, fostering social inclusion and supporting SDGs on education and reduced inequality. Studies cited by the International Telecommunication Union suggest that a 10% increase in internet access can increase GDP per capita by 2.5–2.8 %. Growing LEO constellations can help to reduce the digital divide<sup>84</sup>.

### Sustaining life beyond Earth

If sustainability on Earth is about preserving ecosystems and human welfare within planetary boundaries, then space technology extends this logic into the cosmos. The ultimate expression of “sustainable development” is the long-term survival of life and consciousness itself. Advocates such as Elon Musk and Carl Sagan have argued that establishing a self-sustaining human presence beyond Earth would safeguard civilisation against existential risks – from asteroid impacts to nuclear conflict or runaway climate change. In this view, becoming a multiplanetary species is not escapism but continuity: ensuring that the story of life and awareness does not end with a single planet.

*"Our planet is a lonely speck in the great enveloping cosmic dark. In our obscurity — in all this vastness — there is no hint that help will come from elsewhere to save us from ourselves"*

**CARL SAGAN, PALE BLUE DOT (1994)**



Image: NASA, The Pale Blue Dot – photograph of Earth taken by Voyager 1 on 14 February 1990<sup>85</sup>

The Pale Blue Dot is a photograph of Earth taken on the 14 February 1990, by NASA's Voyager 1 at a distance of 3.7 billion miles (6 billion kilometres) from the Sun. The image inspired the title of scientist Carl Sagan's book, "Pale Blue Dot: A Vision of the Human Future in Space," in which he wrote: "Look again at that dot. That's here. That's home. That's us."

Life beyond Earth is an issue worth pondering. The Fermi Paradox<sup>86</sup> poses a question that has haunted scientists and theologians alike: if the universe is so vast and old, filled with billions of stars and habitable worlds, why have we seen no evidence of other intelligent life? The Drake Equation provides a framework for estimating the number of civilisations in our galaxy. Depending on the assumptions used, it can imply anything from a lonely universe to a crowded one – which is why the continued silence remains so challenging to interpret. Either way, the implication is unsettling: we may be alone. If consciousness has arisen only once, then preserving it becomes not just a technical challenge but a moral one. In that sense, space exploration represents a new dimension of sustainability – the safeguarding of life itself, on and beyond Earth.

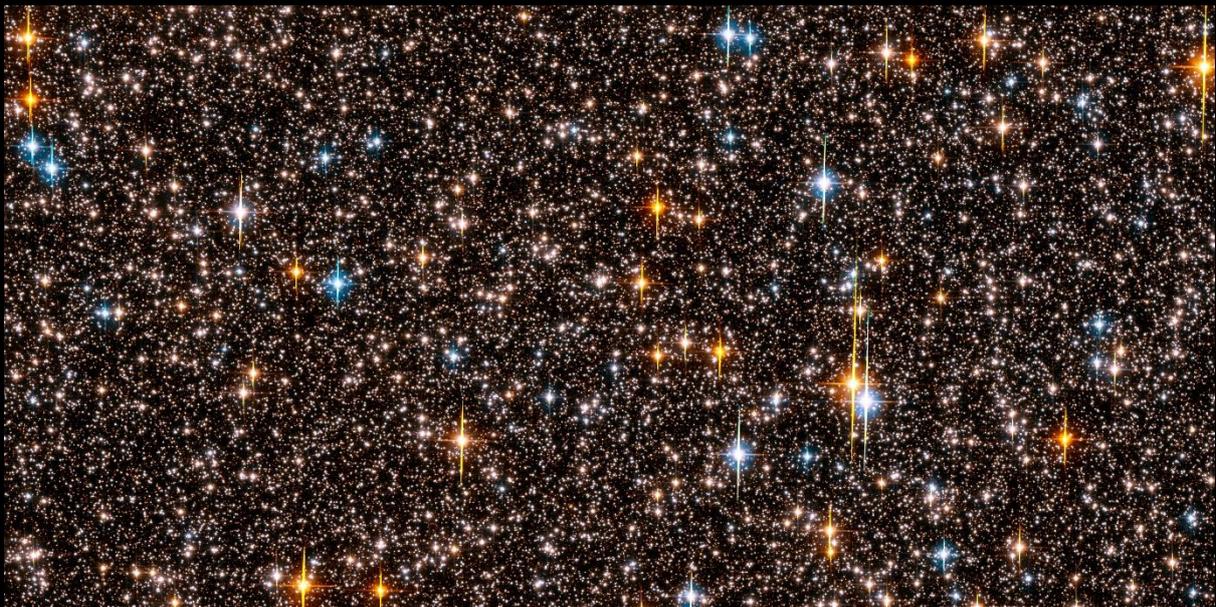


Image: NASA/ESA, *Half of the Hubble Space Telescope field of view in the Sagittarius Window Eclipsing Extrasolar Planet Search (SWEEPS)*<sup>87</sup>

An image of one-half of the Hubble Space Telescope field of view in the Sagittarius Window Eclipsing Extrasolar Planet Search (SWEEPS). The field contains approximately 150,000 stars, down to 30th magnitude. The stars in the Galactic disk and bulge have a mixture of colours and masses. The field is so crowded with stars because Hubble was looking across 26,000 light-years of space in the direction of the centre of our Galaxy. Hubble identified 16 candidate stars that are orbited by planets with periods of a few days. Planets so close to their stars with such short orbital periods are called "hot Jupiters".

## Accelerating the Green Transition

A cornerstone of the green transition is the extensive electrification and digitisation of societies. A 2025 Ecology & Society study<sup>88</sup> notes that digital infrastructure depends heavily on satellite services; many future green and smart systems will rely on near-Earth space. Satellites can facilitate the circular economy by providing digital “twins” of the Earth, enabling monitoring of material flows and resource efficiency. Sectors benefiting from this innovation include agriculture, energy management and mobility, which use satellite data to optimise operations and reduce waste. Without space-based services, implementation of policies like the EU Green Deal and the US Inflation Reduction Act would be far more challenging.

## Space mining and resource use

Harvesting minerals in outer space offers the potential to meet rising global demand for critical raw materials while reducing the environmental pressures of mining on Earth. Asteroids, the Moon and other celestial bodies contain abundant deposits of platinum-group metals, rare earth elements and water ice – resources vital for clean energy, electronics and rocket fuel. By sourcing materials in space, humanity could alleviate the ecological damage caused by mining on Earth and secure a more sustainable supply chain for advanced technologies. In the long term, **in-situ resource utilisation (ISRU)** – using materials found in space rather than transported from Earth – could make it possible to build structures in space, produce fuel and generate essential resources such as oxygen and water that humans need to live and work in space, paving the way for a self-sustaining space economy that ultimately benefits life on Earth.

## Economic and scientific benefits

Finally, there is the economic argument. The space sector is a growing economic engine, far in excess of global GDP. Space-based services support telecommunication, navigation and weather forecasting industries worth billions of dollars. In the future, it may support breakthroughs in healthcare and technology that changes our very way of life.

Exploration missions advance scientific knowledge and inspire technological innovations. Advocates like Jeff Bezos and Elon Musk argue that expanding into space could eventually relocate heavy industry off Earth, preserving Earth as a “*national park*”.

## CONCLUSION

It would take something cataclysmic to stop the Space Economy being far larger in the future than it is today. Its likely growth will have profound impacts for humanity, both here on Earth and beyond. What began as a state-driven race has evolved into a commercial ecosystem spanning launch, satellites, enabling technologies, data and analytics. The most dynamic growth is now downstream, in the services that translate space-derived data into real-world insight – broadband, navigation, climate intelligence and logistics. These “reach” revenues already rival the traditional “backbone” of launch and manufacturing, showing how space is becoming an invisible but essential layer of the global economy.

For investors, the investable frontier increasingly lies not with the headline-grabbing giants but with the smaller, quoted and private companies enabling this transformation. Across the value chain, Small & MidCap specialists are active in every layer of the Space Economy – from building and operating infrastructure to supplying enabling technologies and delivering data-driven services. Their expertise spans sensors, communications, propulsion, robotics and analytics, providing the hardware, software and intelligence that keep the ecosystem functioning. These companies combine innovation with operational discipline, generating recurring revenues and building high barriers to entry in a market still in its infancy.

The next phase of growth will also be shaped by geopolitical divergence. China’s state-driven model – integrating government, military and commercial capabilities – is accelerating advances in heavy-lift launch, lunar infrastructure and Earth-observation, supported by national leadership in semiconductors, quantum communications and AI-enabled sensing. India is rapidly scaling its own ecosystem through ISRO’s low-cost engineering excellence and a surge of private start-ups following regulatory reform, positioning itself as a competitive launch and data-analytics hub.

At the same time, the US and allied markets are witnessing an unprecedented handover of capability from the state to private enterprise, with companies now outperforming or out-innovating national space agencies in launch, satellites, data processing and AI-driven on-orbit services. The tension between state-led and commercially-led models – and the parallel race for leadership in chips, AI and space-enabled data infrastructure – will define where value and strategic advantage accrue over the coming decade.

Humanity’s expansion into space may prove the defining technological story of the millennium. As the Russian scientist and thinker Vladimir Vernadsky, who pioneered the concept of the biosphere and humanity’s role within it, wrote, *“wider and wider creative possibilities open before us.”*<sup>89</sup>

Or as one early **SpaceX** engineer more simply reflected: *“I’ve come to realise that we’re still just at the beginning.”*<sup>90</sup>

**Montanaro will continue to monitor these developments closely, seeking high-quality, enduring businesses that translate the promise of space into tangible value for investors – and, ultimately, for life on Earth.**

# THE FUTURE: OUR PREDICTIONS FOR THE NEXT 100 YEARS

## 1. Lunar cities

Permanent human bases on the Moon become reality – self-sustaining habitats powered by in-situ resources, manufacturing and solar energy. The first true off-world economy begins.

## 2. Mars settlements

Colonies thrive inside pressurised domes and silica-aerogel “greenhouses” that warm the surface and protect against radiation. Terraforming remains centuries away, but pockets of life take root.

## 3. The space elevator

A tether stretching 100,000 km into orbit makes the journey from Earth to space routine. Electrically powered climbers haul cargo daily, cutting launch costs a hundred-fold and unlocking mass movement beyond Earth.

## 4. Orbiting habitats

Vast rotating O’Neill cylinders house thousands, offering artificial gravity, farmland and sunlight. Humanity learns to build whole ecosystems in orbit – a second cradle for civilisation.

## 5. Asteroid mining

Having mastered the mining of lunar regolith, robotic refineries harvest platinum, water and oxygen from near-Earth asteroids. Propellant depots and rare metals fuel a new space-industrial age.

## 6. Manufacturing in orbit

Metal 3D printers and autonomous factories build spacecraft and infrastructure directly in microgravity. Space begins to make things for itself.

## 7. Space-based solar power

Giant orbital arrays beam clean energy to Earth day and night. What began as a NASA experiment becomes a planetary power grid.

## 8. Advanced propulsion

Nuclear and directed-energy drives cut travel times from months to weeks. The outer planets fall within reach — and interstellar flight becomes conceivable.

## 9. Interstellar probes

Laser-driven nanocraft sail at one-fifth the speed of light toward Alpha Centauri. Humanity’s first messages cross the void between stars.

## 10. Cosmic observatories

Starshade telescopes image Earth-like worlds. Gravitational-wave antennas millions of kilometres apart listen to the universe’s earliest echoes – turning the cosmos itself into our laboratory.

If you want to get truly futuristic,  
we recommend watching this breathtaking short film:

**A JOURNEY TO THE END OF TIME BY [WANDERERS](#)**



Image: ESA/NASA, *The Orion Nebula – composite image from the Hubble Space Telescope*<sup>91</sup>

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until it becomes the universe itself*

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