ReOrbit

Innovation & Entrepreneurship

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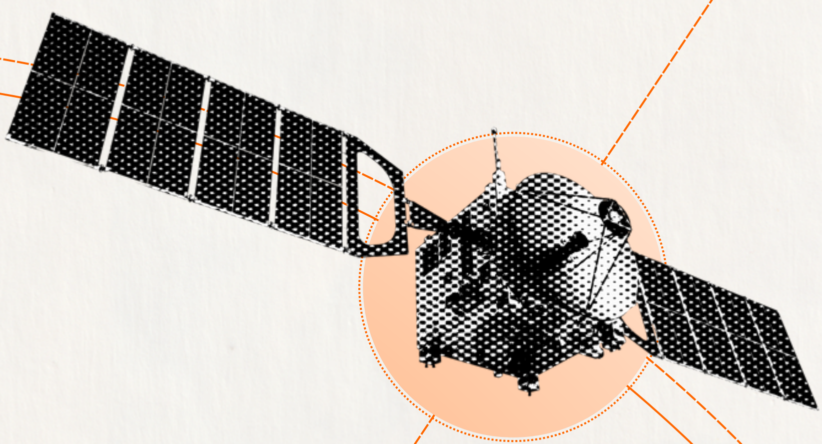


1 Executive Summary

1.1 The Problem & Solution

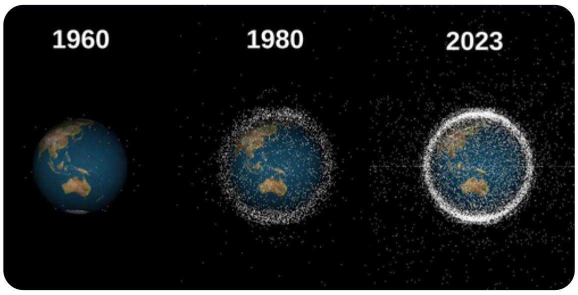


Figure 1: Accumulation of Space Debris

Problem

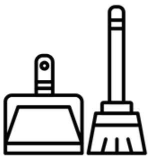
128 million pieces of space debris larger than 1 millimetre are **orbiting Earth.** Although small in relative terms, their speed can cause catastrophic damage to useful space hardware on impact. This poses a **significant threat** to other satellites in orbit.

Hundreds of collision avoidance manoeuvres are performed every year, including by the International Space Station (ISS). With the number of satellite launches rising exponentially, the space debris problem will get worse, making **Earth orbit unusable**. Current solutions do not address the scale of the issue, and do not **provide financial incentive** to debris owners to remove their defunct hardware.

Solution

ReOrbit develops an Active Debris Removal system targeting, capturing, and transporting small-medium space debris, at scale. Our concept consists of a sustainable **satellite network** in Low Earth Orbit with the capacity to alter debris trajectories, then physically capturing targets before transporting them to clients. These clients use the captured debris for their **in-orbit applications** (propellant production, manufacturing, construction, …). We can also service clients that need their defunct satellites removed from orbit.

How Does it Work?



ReOrbit will operate a '**dustpan and brush**' system in which **laser-equipped satellites** are used to alter the trajectory and speed of a targeted piece of space debris, in order to allow a mobile robotic collection vessel to grab and relocate the object to a paying third party which can recycle or reuse the valuable materials.

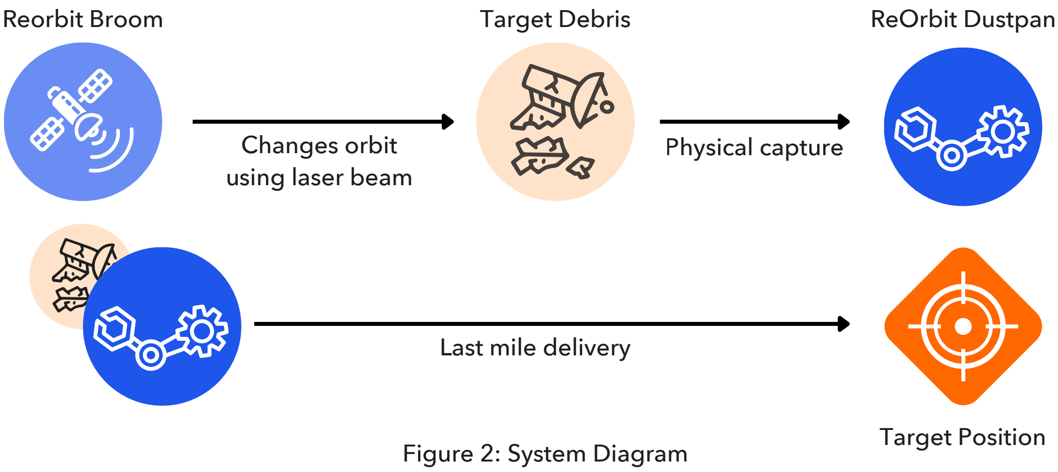


Figure 2: System Diagram

Key Technology 1 - The Broom

The "broom" satellite concept is a satellite fitted with a powerful **laser beam** that can be used to target debris. This allows us to exert a small but precise force which alters the its trajectory and velocity, requiring much less energy expenditure than direct rendezvous and capture, and is more scalable. This allows us to group target debris in the same region/orbit for the "dustpan" manoeuvre.

Key Technology 2 - The Dustpan

The "dustpan" satellite is in a stable orbit such that it minimises propulsive manoeuvre to directly intercept debris which has been placed in its trajectory by the broom. It uses robotic **manipulators** to directly collect and secure the space debris before taking it to a designated third party for in-situ remanufacture or recycling.

Figure 3: ClearSpace-1

Our Design Process

We converged on this solution after going through a rigorous diverging then converging design thinking process. We used thorough primary (expert interviews) and secondary (literature review) to gain a broad understanding of technical feasibility of Active Debris Removal technologies, and other operational and regulatory constraints when working in the space industry. We selected the idea using a combination of expert feedback and evaluation against design requirements.

1.2 Our Business

How do We Provide Value?

We provide value to two customer bases:

1. Satellite operators who contribute to the proliferation of space debris. They are driven by the constraint of debris regulation but also the want to recuperate some of the cost of their mission
2. Companies in the In-Orbit Services and Manufacturing (IOSM) market. These firms have a demand for material in space for a variety of applications including propellant production and manufacturing.

We buy the debris off the satellite operators and resell it to the IOSM firms, who are not focused on developing scalable capture and transport infrastructure.

How do we Compete in the Market?

We are addressing a new gap in the market spurred by the recent development of stricter space debris guidelines, advances in space technology. Our unique selling point is that we pay satellite operators to salvage their debris, instead of them paying 3rd parties to dispose of it. The SOM market opportunity was calculated to £0.8-1.1 million, and growing. We have a small amount of direct competitors.

Our Key Assumptions

- We obtain sufficient funds from space agency and government R&D grants
- Our R&D efforts lead to technical success, especially for the laser broom technology
- Parallel advances in the IOSM sector will fuel demand and profitability of our business model

Sales Channels

ReOrbit uses multiple sales channels, including direct **partnerships** with satellite operators for End of Life (EOL) management, as well as **subscription-based contracts**IOSM companies that are looking to source space debris to be harvested, Space industry and technology trade shows in which business-to-business relationships can be established, and finally digital marketing through the medium of targeted outreach campaigns to the most relevant stakeholders in the space industry.

Profit & Loss

The main sources of income for Reorbit are **service fees** for debris relocation or trajectory adjustment and subscription fees for clients who have ongoing ambitions regarding space debris. We aim to sign £1M worth of contracts with customers on our third year, as we prepare to launch our first satellites. The major expenses are **R&D** of the two satellite systems, manufacture of satellites, **launch** operations, and maintenance and operation costs of the satellites.

2 Value Proposition

ReOrbit revolutionises space sustainability by **providing active debris removal solutions that exceed regulatory compliance**, delivering tangible value to satellite operators. Our cutting-edge, laser and robotics-enabled satellites **sustainably capture and transport small debris at scale** across Low Earth Orbit, ensuring efficient operations for the In-Orbit Servicing and Manufacturing (IOSM) industry. We act as a platform between debris owners and clients, **we help transform orbital waste into valuable resources**, reducing collision risks, protecting assets, and contributing to a circular space economy.

2.1 Why is Space Debris a Problem?

Earth's orbital environment is a finite resource.

Space debris poses a pressing threat to **sustained activity in orbit** (satellite communication networks, Earth observation, national security, human spaceflight, ...). As orbit congestion increases, so does the **risk of catastrophic collisions** between debris and active satellites. This risk is **increasing exponentially** (Figure 4) as we launch more satellites into orbit. Nearly **75%** of the objects tracked in space are classified as debris, and millions of fragments untracked, even down to millimetre-sized fragments, are capable of degrading or destroying spacecraft [4]. Damage can range from deformations on impact (Figure 1) to complete destruction, which generates even more debris, which **in turn can impact more satellites** (Figure 2).

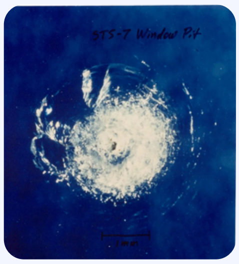


Figure 4: Impact of a fleck of paint on the Space Shuttle window - damages were large enough to **warrant replacement** of the window. [5]

Figure 5: Debris field of the first accidental collision between an active satellite and space debris - it created **2000 large debris fragments** from the collision [6]

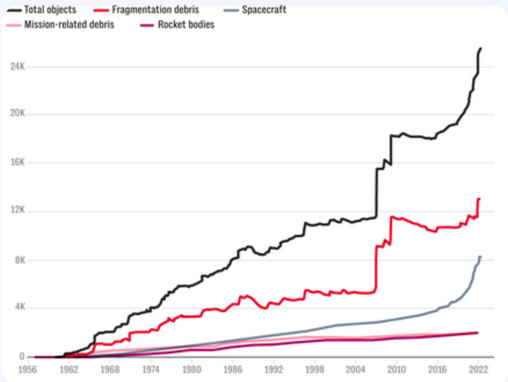


Figure 6: Growth in The Number of Tracked Debris [4]

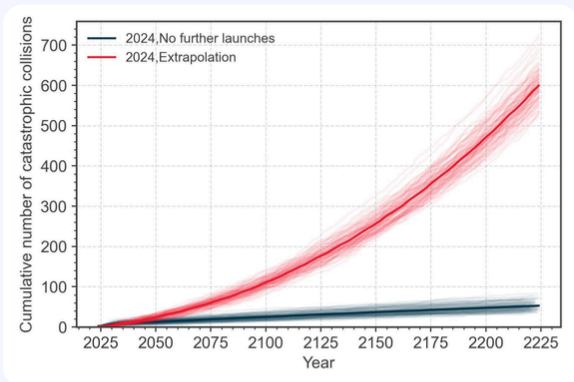


Figure 7: Projected exponential increase in number of cumulative collisions in orbit [7]

The ReOrbit Key Insight

We realised that the main issue plaguing the active debris removal sector is the question: **who is going to pay for this?** Space agencies will not foot the bill forever.
We understand that for industry-wide adoption of keeping orbit clean, producers of space debris need more than non-binding guidelines, **they want financial incentives**.
We answer this industry-wide need by leveraging the growing demand for material for the In-Orbit Services and Manufacturing market (McKinsey & Co. estimates that that it could reach £10 billion by 2030 [9]) by using the material that's already there.

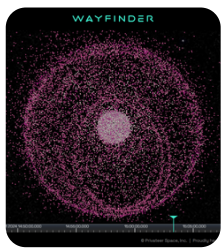


Figure 8: Visualisation of space debris [8]

2.2 Value Proposition Canvas

Client Profile 1: Satellite Operators

Customer Jobs

- Operate satellites
- Ensure responsible satellite disposal at the end of their operational life.
- Maintain compliance with international space regulations

Gains

- Affordable and reliable satellite disposal services
- Improved sustainability and public image
- Free up positions in orbits in which their new satellites can be placed

Pains

- Costs and technical challenges of de-orbiting satellites forced on them by space agencies
- Risk of contributing to space debris, leading to operational and reputational damage

Client Profile 2: IOSM companies

Customer Jobs

- Deploy and operate In-Situ Resource Utilisation (ISRU) technology from space debris materials (propellant, structures, alloys, ...) .

Gains

- Cheap and regular supply of materials
- Improved sustainability and public image

Pains

- Sourcing costly materials from Earth
- High costs and technical challenges developing their core IOSM offering

Gain Creators

- Satellite operators are remunerated for their space debris
- Increased availability of high grade specialist recycled materials for in-orbit manufacture
- Mitigation of the hazards posed by space debris

Pain Relievers

- Reduce financial burden associated with satellite EOL disposal, which comes from reserving fuel for deorbit manoeuvre → decreases mission lifespan and revenue
- Assist IOSM to access valuable materials
- Support satellite companies in meeting international compliance standards

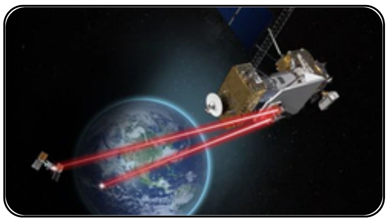
Products & Services

- Laser-based trajectory and velocity adjustment of in-orbit debris
- Robotically-facilitated collection and relocation of debris to assigned locations
- Ongoing debris management services for satellite operators (subscription and one-off model)
- Short-term storage and transportation solutions in space (using ReOrbit technology)

Figure 9: Value Proposition Canvas

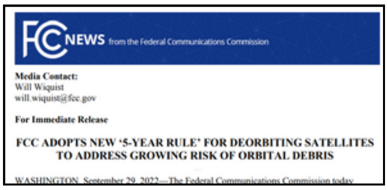
2.3 Why Has Nobody Done This Before?

- The core technology used by ReOrbit is still very early stage, particularly the laser-based "broom" system. We can attribute this to space debris solutions not being taken seriously by space agencies until the first accidental collision between an active telecommunications satellite and a inactive debris satellite in 2009.
- Regulations and guidelines defining satellite end-of-life best practices have only existed for less than 10 years, meaning until now, demand for these solutions has been very low.
- Until now space debris producing companies have had **no financial incentive** to invest in active space debris removal.
- The IOSM industry to which we aim to supply debris material is also in its infancy and international legislation regarding **ownership of space debris** is extremely strict now, but is showing signs of relaxing.



(a)

(b)



FCC NEWS from the Federal Communications Commission

Media Contact:
Will Wiquist
will.wiquist@fcc.gov

For Immediate Release

FCC ADOPTS NEW '5-YEAR RULE' FOR DEORBITING SATELLITES TO ADDRESS GROWING RISK OF ORBITAL DEBRIS

WASHINGTON, September 29, 2022—The Federal Communications Commission today

(c)

Figure 10: (a) laser-based broom system. (b) robotic capture satellite. (c) 5-year rule

2.4 Example Scenario

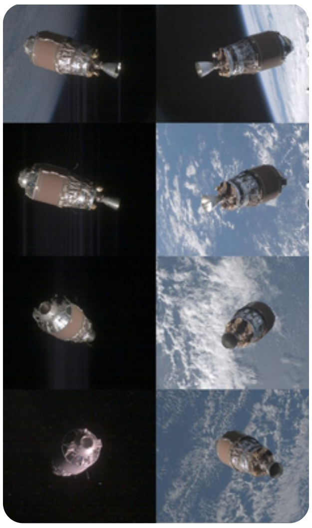
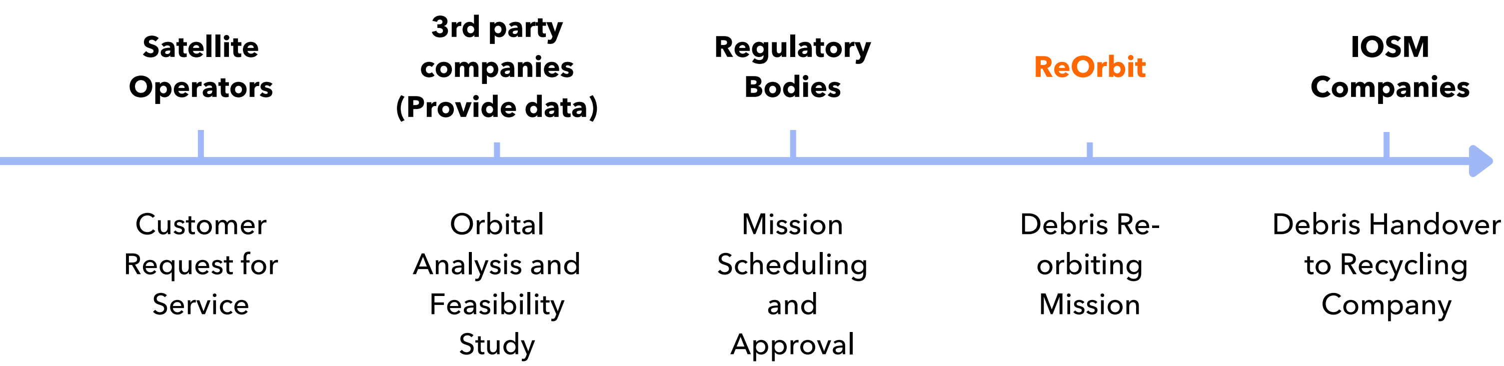


Figure 11: Space debris taken by Astroscale's ADRAS-J spacecraft

OneWeb, a UK-based satellite communication provider wants to gradually update its satellite constellation to the next generation design. However, because their previous generation of satellites was deployed before the ESA Zero-Debris Charter was announced, this old network is not designed to de-orbit and break up in the atmosphere, posing a hazard for other satellites and space structures.

Were it not be for ReOrbit, OneWeb would only have 2 options: leave their debris orbiting and risk catastrophic collisions, or pay an Active Debris removal company like Astroscale a large sum to remove one satellite out of the near 600 in their network.

This is where we provide value: our in-orbit infrastructure allows us to efficiently capture the defunct OneWeb satellites. We incentivise this by paying them for their debris, which we are fund from the resale of this debris to IOSM companies such as Magdrive, which use it to produce satellite propellant.



3 Design Journey

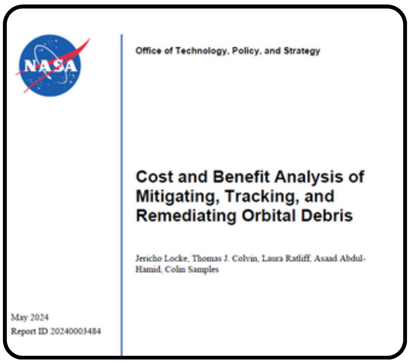
Our design process followed the diverging/converging framework. We outline how we defined the ReOrbit concept and why other concepts were not taken forward.

3.1 Divergent Thinking - Literature Review

We kicked off the process using secondary research with **3 main objectives**:

1. Understand the **history of space debris mitigation solutions**: how has the industry evolved with new technologies?
2. Understand the **drivers behind these new companies**: which organisations and institutions are driving demand for these solutions, who are they?
3. The **future of this sector**: what solutions and business models seem to be working, and why have others failed?

We read the latest industrial and academic publications in the field of space debris. Below are the key insights from a **selected** collection of papers/reports.



NASA - 2024 [10]

History

Early recognition of space debris risks began in the **1960s** and escalated in the **1970s** with reports like Donald Kessler's syndrome hypothesis, predicting cascading collisions

Drivers

Organisations like the U.S. Space Force and Air Force have vested interests in maintaining operational orbits for **national security**.

Future

Advocates rapid deorbiting and cost-effective debris removal through **nudging technologies**

Acta Astronautica - 2023 [11]

History

Explains "early solutions" eg international standards to **deorbit** or move to **graveyard orbit** spacecraft post-mission

Drivers

Demand spurred by the operational risks posed by **increasing space debris density, linked with growth of mega-constellations (SpaceX)**

Future

Emphasises need for **scalable** Active Debris Removal, but **cost and feasibility will be major challenges** for widespread adoption

ESA - 2024 [12]

History

Highlights the importance of standardising global measures for mitigation, such as the **2002 IADC** (Inter-Agency Space Debris Coordination Committee)

Drivers

Cleaning orbit for future **human spaceflight** to the LEO or the Moon. Also, intense **space weather events** which can cause satellites to re-enter, are becoming more frequent

Future

Suggests **stricter policies and remediation initiatives** like ESA's Zero Debris Policy

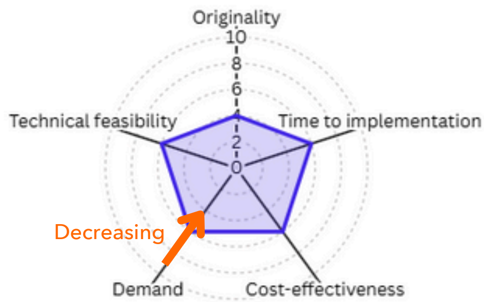
3.2 Divergent Thinking - Initial Ideation

Design Opportunity

Existing solutions provide the baseline value of removing space debris in some way, but **none go beyond** using the captured debris for another value-generating purpose. This is crucial because space debris mitigation faces a **massive financial incentive issue**, similar to Earth-based companies. Firms are more likely to invest in sustainable practices under pressure from the government or using state subsidies. The same is currently true for Earth orbit sustainability. So, there is an opportunity to provide genuine financial value from unactive satellites and debris to a variety of **stakeholders** including satellite manufacturers and NewSpace companies building the Low Earth Orbit economy. We generated 3 ideas that address the **market gap of generating value from space debris other than simply removing it**. We then scored each concept on a radar graph to begin the evaluation stage.

Idea 1: Return to Earth

- **Concept of operations:** Capture inactive satellites and large space debris in a re-entry capsule, before returning to Earth (splash landing in an ocean).
- **How does it provide value?**
  - Gives satellite operators the opportunity to **analyse hardware once it is been to space** → optimise next generation designs.
  - **Salvage expensive components** → re-integrate into new models manufactured on Earth.
  - Sell **scrap material to the luxury market** → watch makers, consumer tech, automotive could use it as a USP (Omega + Rolex already use meteorites).



Overall score: 5.6 / 10

Idea 2: Reuse in Orbit

- **Concept of operations:** Capture inactive satellites and large space debris in a large capsule, for transport to a centralised recycling / reuse hub in orbit.
- **How does it provide value?**
  - Gives satellite operators the opportunity to **replace specific broken components in orbit** → fixing instead of replacing lowers costs.
  - **Salvage expensive materials** → scrap hardware and sell precious metals.
  - Support the **construction of larger structures in space** → lowers launch cost of fresh materials (space stations, ...).

Overall score: 6.8 / 10

Idea 3: Transport to Other Worlds

- **Concept of operations:** Capture inactive satellites and large space debris in a large capsule, for transport to other distant places in the solar system (lunar orbit/surface, Mars, ...).
- **How does it provide value?**
  - Support the **construction of future infrastructure in space** → lowers launch cost of fresh materials to construct bases, stations the solar system, supporting interplanetary missions.

Overall score: 4.4 / 10

Figure 12: Ideation Radar Charts

3.3 Convergent Thinking - Expert Interviews

Next, we reached out within our social, academic and professional networks to set up in-depth interviews. Our goal was to identify key insights by:

- **Gaining a deeper understanding** of space debris and IOSM industries (trends, dynamics, players)
- **Receiving technical guidance** on our initial concepts (feasibility, cost-effectiveness, R&D timeline)
- **Clarify our assumptions** to steer our ideation (at an industry/sector level)

We reached out to 11 people, from academia and industry, and received 3 replies. Below are the key insights and quotes from the interviews we conducted.

Ivan Revenga Riesco - Hardware Engineer @ Alen Space / RA @ ICL

- New satellite mega-constellations are **designed to de-orbit**
- Some hardware could be reused, but most satellites carry **specialised payloads which cannot be reused** (sensors, instruments), also technology improves which makes **some components redundant**
- "There will be a **Low Earth Orbit economy** soon"

Harshav Mahendran - Mechatronics Architect @ Orbit Fab

- Look at **salvage economics** on Earth, how much do people pay?
- Companies will not want to return materials to Earth, especially with **cost of launch being lowered** dramatically (SpaceX)
- "You can **only start with investment when it comes to space**, but it can also be **paid for by the government**"

Matvey Boguslavskiy - R&D Engineering Contractor

- Next generation spacecraft propulsion could **run on space debris, as the industry shifts to prolong mission lifespan**
- Most space debris mitigation companies are focusing on large spacecraft, but there is an **opportunity to address smaller debris** which is much more prevalent and can just as harmful
- **Robotic capture** of debris can be very effective

Selected Insights

All experts agreed that extracting the most value from space debris would have to happen **in-orbit**, and integrate **robotic manipulation**. They also highlighted the necessity to narrow down our scope of what type of space debris we will interface with.

Final Idea Selection

Thanks to our primary research, we confirmed our evaluation carried out in the initial ideation stage. Going forward, we will develop **Idea 2: Reuse in-Orbit** because the client base is increasing, and is feasible. **Idea 1: Return to Earth**, was not carried forward as with launch cost/Kg is dropping rapidly, so the value gained from reusing material on Earth will decrease. **Idea 3: transport to other worlds** was also not carried forward because although there is a use case in the future, demand is too low now.

3.4 Convergent Thinking - Design Refinement

Having selected **Idea 2: Reuse in Orbit**, we will define key requirements, enabling technologies and system architecture. Our starting point recommended by our experts was to **consider a solution with a network of multiple satellites** in Low Earth Orbit to maximise serviceable area and potential revenue.

High-Level Requirement (HLR) Definition

HLR1. The satellite network shall **capture** a minimum of 50 pieces of space debris per year, each with a mass between 10 and 1000kg, for a **minimum of 10 years**

HLR2. The satellite network shall **transport** captured debris to a designated orbit or rendezvous point within 15 days of capture

HLR3. The satellite network shall support **coordinated operation** of at least 20 satellites, ensuring uninterrupted debris removal coverage across 95% of the LEO region

Concept of Operations: How Will it Work?

The key value add of the ReOrbit network must be to efficiently capture and transport small-medium space debris at scale in Low Earth Orbit. However, all space debris targets follow slightly different orbital trajectories. We need to physically interface with these targets, for this we need advanced space and Earth-based sensing technology to identify targets and predict trajectories **(1.)**

We deploy our "broom" and "dustpan" systems. The "broom" consists of aiming a high-intensity satellite-based laser at the target to slightly nudge its orbit, to make it line up with our "dustpan" **(2.)**: another satellite equipped with robotic capture capabilities and highly precise thrusters to physically grab the target debris, and place it in a large storage capsule **(3.)**. The "**broom**" is critical to this scalable system because the amount **propellant** needed for the "dustpan" to move to each target would make the mission unfeasible. The "broom" does not require any limited propellant, operating the laser solely from **solar power**. Once done, this process can repeat until the storage capsule is full. This "dustpan" spacecraft can use its **propulsion** systems to change orbit and reach its target client rendezvous point or orbit **(4.)**. This provides **value** to the client as they can use material for their own applications, as well as the owner of the debris, who will meet international requirements and get a cash kickback from the transfer of scrap material. More details in the Appendix.

Full System Timeline

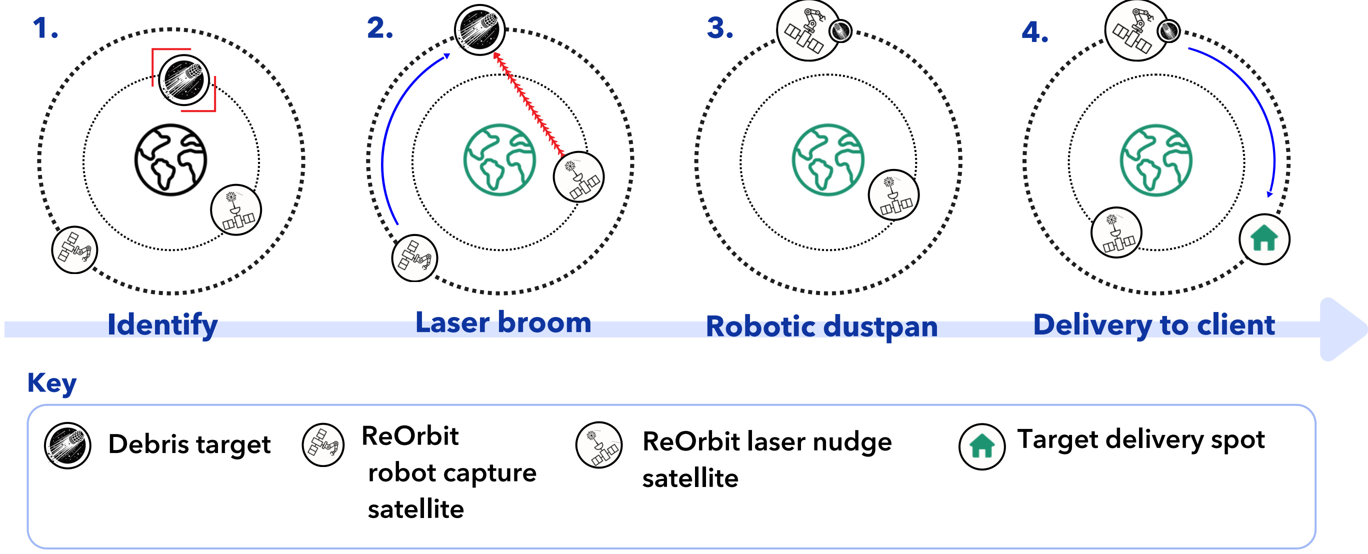


Figure 13: Full System Timeline

4 Business Model

4.1 Regulations in the Space Industry

The space industry is heavily influenced by regulations and policies; therefore, an appropriate business model needs to be in line with those, in order to avoid unforeseen risks. New emerging policies are bringing both new opportunities and potential challenges to our concepts.

Positive Regulations (Opportunities)

Promotion of Debris Recycling


IADC Space Debris Mitigation Guidelines


ESA Space Debris Mitigation Requirements


U.S. Government
Orbital Debris Mitigation Standard Practices, November 2019 Update

PREAMBLE

IADC
ISpace Debris Mitigation Guidelines [13]

ESA
Space Debris Mitigation Requirements [14]

US
Orbital Debris Mitigation Standard Practices [15]

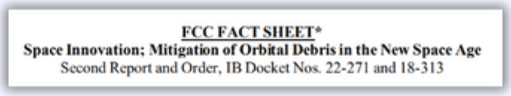
Emerging policies are promoting space debris mitigation and recycling. Governments and international organisations are **more likely to fund or subsidise projects in line with the concept of sustainability.** It also opens up wider possibilities for collaborations with agencies and entities actively promoting the circular space economy.

Negative Regulations (Challenges)

Ownership and Liability Complexities


Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies


The International Traffic in Arms Regulations (ITAR)


FCC FACT SHEET*
Space Innovation; Mitigation of Orbital Debris in the New Space Age
Second Report and Order, IB Docket Nos. 22-271 and 18-313

UN
Outer Space Treaty [16]

US
International Traffic in Arms Regulations [17]

US
"Five-year rule of deorbiting LEO satellites" [18]

According to the Outer Space Treaty of 1967, ownership of debris remains with the launching state, complicating legal matters in the handling and recycling of debris. The International Traffic in Arms Regulations of the US restricts the export of satellite components and technologies.

These challenges call for collaboration with space agencies, satellite operators, and international committees to obtain consent for re-orbiting and recycling operations. Legal barriers could delay service delivery timelines and increase operational costs in this process; **hence, any structures in the business model that could lead to longer or repetitive sequences should be avoided.**

Key insights: The emerging policies are promoting space debris management as well as debris recycling, strengthening our case for receiving **R&D funding** from governments. However, the lack of uniform standards across countries could lead to **ownership complexities** and **delays in timelines**, hence we need to take it into account when planning our system.

4.2 Business Model Canvas

Key Partnerships

Satellite Operators

IOSM Companies: Customers of the re-orbited debris for in-situ resource utilisation

Space Agencies: For funding, support, regulatory compliance

Launch Providers: Companies like SpaceX, Arianespace, Rocket Lab

International Committees: For international coordination of debris ownerships, IADC and UNOOSA

Space situational awareness companies: For tracking data

Value Propositions

Satellite Operators:
- Affordable end-of-life disposal services to meet regulatory requirements
- Reduced collision risks.
- Emptied position in orbit for new satellites
- Sell material in orbit

Governments and Space Agencies:
- Contribution to a sustainable space environment and circular economy

In-Space Manufacturers:
- Constant supply of repurposed materials for specific activities

Customer Segments

Satellite Operators:
- Commercial: Large-scale operators like SpaceX (Starlink), OneWeb, and Amazon (Kuiper)
- Military: Defense organisations requiring secure and compliant debris removal
- Scientific: Universities and research institutions managing scientific satellites
- Amateur: Small satellite operators and hobbyists needing affordable disposal services

Space Agencies
IOSM companies

Key Activities

Re-orbiting Operations: Transfer of debris to clients
Partnership Development: Relationships with IOSM firms and satellite operators
R&D: Advancement of in-space mobility and laser-based technology
Marketing: To raise awareness of the service and its value
Data Management and Analytics: Processing SSA data to identify and track debris.

Key Resources

Physical:
- Laser- and robotic- based debris re-orbiting systems
- Manufacturing, Assembly, Integration and Testing facilities

Human:
- R&D engineers (mechanical, power electronics, optics)
- Operations staff (finance, HR)
- Business development

Intellectual:
- Patented re-orbiting technology
- Data on debris trajectories and environments

Financial:
- Funding through contracts, grants, and investments

Customer Relationships

Dedicated Account Management: Long-term partnership with key customers
Dynamic Engagement: Offer flexible pricing for standalone missions and discounts for larger debris tonnage in specific regions to foster efficient operations.
Ecosystem Integration: Establish a Space Circular Economy Hub in order to connect agencies and companies once the business scales.

Channels

Awareness:
- Conferences and trade shows
- White paper publications and LinkedIn marketing

Sales:
- Direct partnership with satellite operators and recycling companies

Delivery:
- Contracts for specific missions

Support:
- After-service reporting on the debris successfully re-orbited

Cost Structure

Fixed Costs:
- R&D expenses for technology development
- Salaries for technical and operational staff
- Infrastructure
- Regulatory Compliance Costs

Variable Costs:
- Operational costs per mission (e.g., fuel cost for precise rendezvous mobility)
- Partnering costs with launch providers and recycling companies

Revenue Streams

Primary Revenue:
- Service fees from satellite operators.
- Service fees from recycling companies for delivered materials.

Secondary Revenue:
- Grants from the Government

Grants and Government Funding

4.3 Distribution & Future Market Segments

Satellite Operators

Agencies & Companies who operate satelites for commercial, military, or scientific purposes

Annual Revenue **$285 billion [19]**

Active Satellites **13000 [20]**

Needs
- Affordable and reliable debris removal services to meet end-of-life regulatory requirements.
- Reduced risk of collisions to avoid costly damage or loss of operational satellites.

Wants
- Simplified processes for compliance and risk mitigation.
- Customised solutions for specific orbits or debris types.
- Assurance of service reliability and quick response times for emergencies.

Segment: Mega-Constellation Operators

Needs
- Continuous debris management for safe operations of large-scale constellations.
- Scalable solutions to recurring debris challenges.

Wants
- Long-term partnerships to reduce operational complexity and risk.
- Collaboration opportunities on sustainability initiatives for an improved brand image.

Segment: Space Agencies and Regulatory Bodies

Needs
- Compliance solutions to adhere to international guidelines on mitigation of debris.

Wants
- Promote innovative companies and boost R&D in their respective geographies

In-Situ Recycling Companies • EMERGING CUSTOMER

Processing orbital debris in space, extracting valuable materials like metals for manufacturing and fuel.

Needs
- Access to materials like aluminium or other resources for manufacturing and fuel production.
- Cost-effective and consistent delivery of debris to designated hubs.

Wants
- Material delivery on-demand based on their capacities.
- Predictable and transparent pricing for material access.

In-Orbit Manufacturers • EMERGING CUSTOMER

Assembling products directly in space, using technologies like 3D printing and welding.

Needs
- A reliable supply of materials to reduce dependence on Earth-launched resources.
- Assurance of material quality for in-orbit manufacturing and assembly.

Wants
- Cost-effective and timely delivery of materials.

4.4 How can we Scale our Company?

Revenue Generation Strategies

Strategies Selection

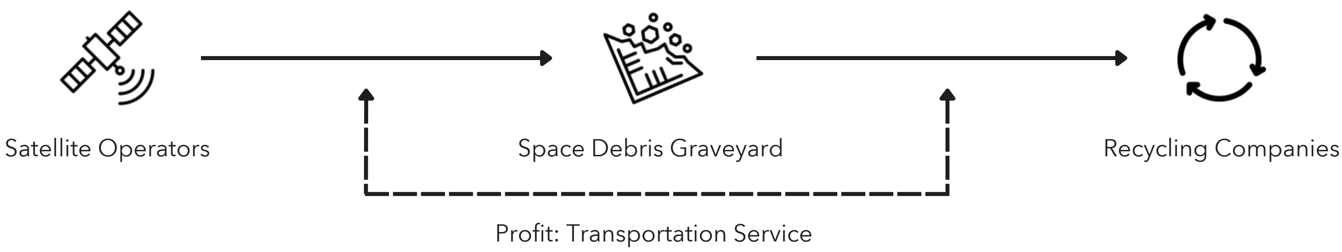
Service-Based Revenue	Debris Tokenization (Blockchain-based)	Satellite Refurbishment	Grants, Investments, & Incentives	Space Insurance Integration	Space Circular Economy Hub

We selected Service-Based Revenue, Grants, Investments, & Incentives, and Space Circular Economy Hub as our strategies. By providing debris transportation services and a platform connecting owners and recycling companies, we avoid unnecessary steps in operation. Other options were excluded to minimise complexity for an efficient and policy-compliant model.

Strategy #1

Service-Based Revenue

Provide debris transportation services directly from satellite operators and space agencies to recycling companies, eliminating intermediary steps and ensuring a streamlined capital flow.



Optional: Subscription Plans

- Offer recurring services to mega-constellation operators, ensuring continuous debris management and fostering long-term partnerships.
- Target Customer: Mega-Constellation Operators like SpaceX's Starlink, OneWeb, and Amazon's Project Kuiper, who requires continuous and scalable debris management solutions.

Dynamic Pricing

- **Debris Hazard Level:** Higher fees for hazardous or difficult-to-access debris, compensating for increased operational risks and complexities.
- **Mission Size and Complexity:** Larger missions that remove more debris in a single operation receive scaling discounts, encouraging bulk service uptake and cost-efficient planning.
- **Orbit-Specific Pricing:** Adjust fees based on the orbital region (e.g., LEO, MEO, GEO) to account for varying operational challenges and resource requirements.
- **Urgency and Response Time:** Premium charges for emergency missions requiring rapid response and expedited services.

Strategy #2

Grants, Investments, & Space agency contracts

Secure funding through government grants, venture capital investments, and incentive programs to support R&D, operational scaling, and technological advancements.

Government Grants
From national and international programs focused on sustainability, space innovation, and debris mitigation.

Private Investments
Attract venture capital, private equity, or space-focused investors to fund R&D, operational scaling, and infrastructure development.

Space agency contracts
Write bids for ESA tenders, potentially collaborating with other more established companies. If won, brings stable cash injection over long periods of time.

Strategy #3

Space Circular Economy Hub

Once our business is **scaled** , we will establish a platform that connects satellite operators and recycling companies, facilitating the exchange of orbital debris and materials. this forum streamlines collaboration by creating linkages between our business partnerships and supports the growth of a circular economy in space. As a platform, it generates revenue through **membership fees** and **transaction charges** for material exchanges.

Cost Structure

Fixed Costs

#1 R&D Expenses
Investment in our re-orbiting systems and debris collection technologies

#2 Employee Payments
Payment for specialised staff, engineers, technicians, and administrative personnel

#3 Infrastructure Expenses
Establishing and maintaining workshops, mission control centers, and orbital assets

#4 Regulatory Compliance
Costs associated with navigating international laws and acquiring operational licenses

Variable Costs

#5 Mission Operations
Fuel costs for collection systems, based on the scale of debris handled

#6 Insurance
Obtaining insurance for our products will be high due to lack of flight heritage, but will decrease with proof of technical success

Path for Expansion

START-UP

Key: S1 Revenue Generation Strategy #1 C1 Cost #1

Phase 1: R&D

- Conduct lab testing of the laser-based re-orbiting system and robotic capture mechanisms.
- Initiate collaborations with leading universities and space agencies to refine orbital autonomy algorithms
- Achieve technology demonstration milestones through numerical simulations and consider microgravity test flights on suborbital platforms

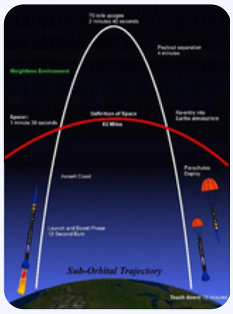


Figure 14: Suborbital Flight Trajectory [35]

Strategies and Costs introduced in this phase: S2 C1 C2 C3

YEAR 3

Phase 2: Launch Core Operations

- Transition from pure R&D to offering standalone re-orbiting services for satellite operators, focusing first on lower-risk and lower-complexity debris scenarios.
- Establish baseline pricing models and early agreements (SLAs) with initial customers.
- Leverage early successes to refine automated targeting algorithms and reduce operational costs through incremental improvements in mission scheduling software.

Figure 15: illustration of space-based lasers [36]

Strategies and Costs introduced in this phase: S1 C4 C5 C6

YEAR 8

Phase 3: Scale-Up and Diversification

- Expand beyond low Earth orbit: Introduce re-orbiting services into MEO and, later, GEO markets as the technology matures and propulsive capabilities improve
- Implement data-driven optimisation tools that predict debris accumulation zones and proactively schedule interventions, enabling a shift from reactive to preventative debris management
- Collaborate closely with in-orbit resource utilisation firms. For example, working on delivering aluminium alloy scrap from debris directly to orbital depots that convert it into satellite fuel rods or structural components

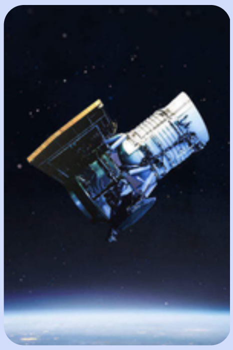


Figure 16: Plasma Thruster by MagDrive [37]

Strategies and Costs introduced in this phase: S3

YEAR 15

5 Market Opportunity

To evaluate the market potential, a structured approach is adopted, incorporating top-down analysis, bottom-up analysis, and scenario-based forecasting. Each method provides unique insights into market size and opportunities [23-79].

5.1 Top Down Approach

The top-down approach begins with a broad evaluation of the global market, narrowing progressively to specific segments aligned with our solution's focus. This method provides a projection of market potential and realistic revenue capture. It integrates insights about the complexity of active debris removal markets and the considerations of a UK-based entrant focusing on medium-scale space debris.

Total Addressable Market (TAM)

- The Global Space Debris Monitoring and Removal Market was valued at £856 million in 2023 [21]
- Projections suggest it could grow to around £1,629 million by 2032 at a CAGR of ~7.4% [22]
- Includes all debris-related services: from passive monitoring/SSA to active debris removal (ADR) techniques (nets, harpoons, tethers, lasers, robotics)

Segment Serviceable Available Market (SAM)

- Active debris removal represents ~30% of the total debris market, as passive monitoring is more mature and widely adopted
    - Laser Brooms and robots Around 20% considering various competing ADR technologies: £52 million
        - Medium-Sized Debris Focus Around 50%: £26 million

Serviceable Obtainable Market (SOM)

- £5.14 million annually, based on 40% operator adoption and 50% market capture of the medium-sized debris removal segment.
- UK/EU SOM: £1.1 million annually, leveraging 20% regional market share and strong regulatory support for space sustainability
- Engaging with established players like Astroscale and ClearSpace

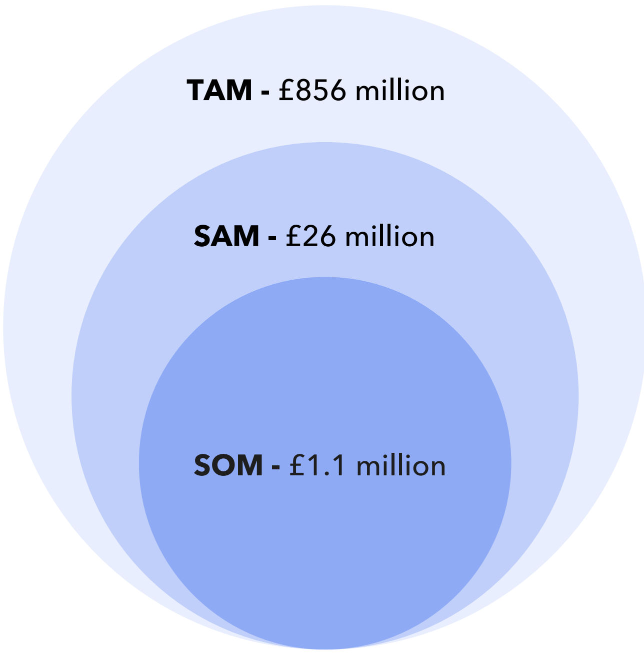


Figure 17: Top down market size calculation

5.2 Bottom Up Approach

Building from granular **assumptions** at the operational level up to the overall market **opportunity**, this approach complements the previously discussed top-down analysis by starting from real-world operational scenarios, user needs, and pricing factors to arrive at a realistic assessment of the Serviceable Obtainable Market (SOM).

1 Identify the Base of Active LEO Satellite Operators

Key customers include commercial mega-constellations (OneWeb, Starlink, and Kuiper), high-value government satellites, entities using the Satellite Applications Catapult's (SAC) ISAM Yard and other facilities for developing and testing space technologies. Assumed around 20 capable LEO operators, including UKSA and international sustainability partners.

2 Estimate the Annual Demand per Operator

Operators encounter hundreds of conjunction alerts annually. High-risk debris in critical orbits requires active removal to maintain long-term satellite operations. On average, each of the 20 key LEO operators identifies 5 critical debris objects per year.

3 Pricing and Unit Economics

At an estimated cost of £200,000 per removal, the total market value is £20 million annually. Initial adoption by 40% of operators would generate demand for 40 removals annually, valued at £8 million.

4 Capture a Share

Capturing 50% of the market provides a £4 million global **SOM**, with **£0.8 million** from the UK/EU

Figure 18: Bottom Up Approach

5.3 Value Theory Approach

The value theory approach ties pricing to benefits delivered, such as collision risk mitigation (£50M+ potential loss), regulatory compliance, and material recovery

- Satellite operators justify ~£200,000 per removal based on avoided costs and operational benefits, while recyclers value materials at £20,000–£30,000 per retrieval.
- Governments fund services to support sustainability, aligning ARPU at ~£200,000 per removal and validating a global SOM of £4M, including £0.8M from the UK/EU.

5.4 Underlying Assumptions & Sensitivity Analysis

This analysis identifies how variations in key assumptions can influence the project's **outcomes**, including market size, revenue projections, and overall profitability.

Financial Assumptions

1. **Cost of Services:** ReOrbit can deliver debris removal services at a cost that ensures profitability while remaining competitive. It is assumed that economies of scale and technological efficiencies will keep costs within a profitable range.

2. **Pricing Structure:** The average pricing for our debris relocation missions is estimated at £200,000 per removal. This pricing is based on the cost-benefit analysis for satellite operators to avoid collision risks and comply with regulatory requirements.

3. **Initial Investment and Setup Costs:** Initial setup costs are covered through a combination of private investment and potential government grants.

Market Scope Assumptions

4. **Growing Demand for Debris Remediation:** Rising space debris, driven by satellite launches and mega-constellations, will increase demand for remediation services. Regulatory pressures and collision risks amplify the urgency for adoption.

5. **Adoption and Market Expansion:** 40% of key LEO operators will adopt services initially, with potential expansion to MEO and GEO markets. Adoption is fueled by compliance needs, financial incentives, and scalable solutions for diverse orbital challenges.

6. **Recycling Market Potential:** A growing market for recycled materials, like aluminium, supports sustainable in-space manufacturing.

Sensitivity Analysis

This analysis evaluates how various factors impact annual revenue, and identifies which assumptions are **critical** and require rigorous validation. Additional factors like accelerated debris growth and expansion into MEO and GEO markets could significantly boost demand beyond current projections.

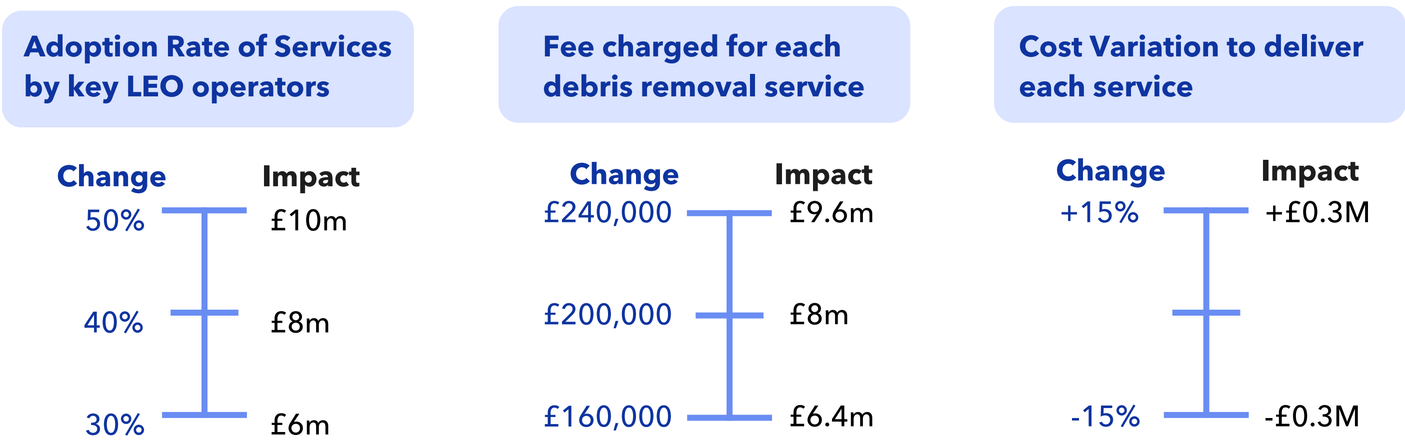


Figure 19: Sensitivity Analysis

5.5 Market Trends

The global space debris remediation market is experiencing accelerated growth, driven by a surge in space activity, increased investment in orbital sustainability, and tighter regulatory measures.

- Space agencies (UKSA, ESA, NASA, JAXA) and national operations centres (such as the UK's NSpOC) are developing new tools to reduce collision risks and promote informed decisions for orbit maneuvering
- The evolving policy landscape, including the US FCC's tightening of orbital lifetime requirements from 25 to 5 years, and international guidelines from the IADC and UN COPUOS, compels satellite operators to adopt debris remediation strategies

P
Political

- Government agencies prioritise space sustainability
- Increased global cooperation with programs like COSMIC or CRD2 fosters international consensus on debris guidelines
- National policies (US FCC's 5-year rule) and European Commission regulations

E
Economic

- Emergence of a service economy around debris remediation: satellite manufacturers, data analytics providers, and in-orbit servicing startups.
- Strong investor interest and funding from government grants and private capital for debris removal technologies.

S
Social

- Growing public concern about space debris impacting critical services (e.g., GPS, communications) drives a push for responsible orbital stewardship
- Increased visibility of high-profile missions (e.g., Astroscale's ELSA, ClearSpace-1) raises social awareness and acceptance of debris mitigation expenses
- Collaboration with academia highlights expectations for cleaner orbits

T
Technological

- Advances in sensors, AI-driven navigation, and autonomous rendezvous and proximity operations (RPO) enable safe capture of non-cooperative debris targets.
- Development of standardised interfaces (e.g., docking plates) facilitates scalable servicing solutions

E
Environmental

- Mitigating debris reduces long-term pollution in LEO and GEO, ensuring sustainable orbital environments for future missions
- Carbon offsets and cleaner production in spacecraft manufacturing reinforce the industry's commitment to environmental stewardship.

L
Legal

- Complex legal frameworks around ownership and liability of defunct satellites push for new international agreements
- Stronger DRM-like conditions in mission contracts to ensure post-mission disposal compliance
- Movement towards "zero debris" guidelines under UN and IADC influence

Figure 20: Pestel Diagram

5.6 SWOT Analysis

This evaluation highlights ReOrbit's innovative technologies and strategic advantages, while also identifying potential challenges and market risks.

Strengths

Innovative, Non-Contact Debris Interaction

- Use of space-based lasers enables precise, contact-free interaction with debris, reducing the risk of accidental fragmentation
- Laser ablation thrust reduces the need to carry propellant to move the debris, making the method more energy-efficient in the long run

Cost and Energy Efficiency

- Reduced fuel consumption for orbit maneuvers by using laser ablation

Alignment with Sustainability Goals

- It addresses a critical space sustainability challenge, appealing to regulators, space agencies, and private operators

Weaknesses

Technological Maturity and Reliability

- Laser-based debris nudging is complex and requires precise aiming, timing, and autonomous control systems. There may be significant engineering and validation challenges before full operational deployment.

High Initial Investment and Long R&D Cycle

- Development of specialised laser payloads, advanced guidance, navigation, and control (GNC) systems, and robust robotic collectors is costly and time-consuming

Uncertain Regulatory Framework

Limited Initial Market Size

Opportunities

Growing LEO Market and Mega-Constellations

- Rapid expansion of commercial constellations increases demand
- Governments, agencies, and insurance providers may require or incentivise debris mitigation services

Value-Added Services

- Captured debris could be repurposed as raw material feedstock for in-orbit manufacturing or used for producing propellant (MagDrive)

Technological Spin-Offs

- Advances in AI laser pointing, optical payload technology, and autonomous robotics could spin off into other profitable space applications, such as proximity operations and in-orbit servicing

Strategic Partnerships

Threats

Competitive Landscape

- Emergence of competing debris removal solutions, such as ground-based lasers, other in-orbit servicing companies, electro-dynamic tethers may reduce market share

Regulatory and Policy Uncertainty

- Shifts in international space law or the introduction of restrictive policies on laser usage in orbit might limit operational flexibility
- Delays in establishing a legal framework for debris removal could slow market growth

Technical and Operational Risks

- Potential failures during demonstration missions could undermine investor confidence

Cost Pressure and Economic Fluctuations

5.7 Competitors

Direct Competitors

Entities that provide active space debris removal services.

Competitor	Service Offerings	Technology	Location	Strength/Weakness	Advantage
ClearSpace	Debris capture and deorbiting, in-orbit servicing	Robotic arms, AI-driven tracking		**S:** Backed by ESA **W:** Limited debris types	Partnership with ESA provides credibility
Astroscale	End-of-life services, active debris removal, satellite servicing	Magnetic docking, autonomous servicers		**S:** Multiple missions planned **W:** Regulatory Challenges	Broad service portfolio and global reach
SKY Perfect JSAT	Active debris removal and satellite LiDAR services	Laser ablation, LiDAR integration		**S:** Academia collaboration **W:** Long Dev timelines (2029)	Leveraging 30+ years of satellite expertise
Orbital Lasers	Laser-based debris deflection and stabilisation	AI-powered lasers, trajectory adjustment		**S:** Highly efficient and compact **W:** High energy requirements	Use of AI for precise debris management

Figure 21: Direct Competitors

Indirect Competitors

Indirect competitors play key roles in the broader ecosystem of space debris management.

Competitor	Service Offerings	Impact	Location	Strength/Weakness	Advantage
OneWeb	Satellite constellation deployment	Implements end-of-life deorbiting for satellites		**S:** Large-scale operations **W:** Focused only on deployment	Extensive network and infrastructure
SpaceX	Satellite internet services, collision avoidance systems	Active deorbiting capabilities		**S:** Technological innovation **W:** Focused only on deployment	Rapid deployment and fleet management

Figure 22: Indirect Competitors

6 Sales & Marketing

6.1 Bull's Eye Framework

Figure 23: Bull's Eye Diagram

Core Growth Channels

Engineering as Marketing

A powerful demonstration tool – like an orbital debris ROI calculator – can attract prospects directly to our website. This conveys technical authority and helps customers understand the tangible benefits of using our service.

Action Steps:

- Developing branded online resources (interactive debris maps, calculators, simulations).
- Launching these tools pre-trade show to drive traffic and capture leads who interact with the tools.

Trade Shows

In-person events are pivotal in the aerospace industry. Trade shows provide a direct line to potential customers, facilitating faster trust-building and relationship formation.

Action Steps:

- A visually compelling booth with demos of our engineering tools.
- Booking private meeting rooms to discuss opportunities with pre-qualified prospects.
- Follow up after the event with customised proposals referencing in-person discussions.

Speaking Engagement

Building thought leadership and establishing our company as a technical authority in the space debris industry.

Action Steps:

- Conference papers / presentations on our core product offering (e.g., "Turning Space Debris into Strategic Assets")
- Publishing recorded talks or webinars on our website and social platforms

Long - Term Growth Channels

Whitepapers & Webinars

Producing technical content establishes our company as the authority on space debris repositioning. We would make these open access.

Referrals & Customer Networks

Once initial customers have success stories, we will leverage them for testimonials, case studies, and referrals to their industry peers.

Supporting Growth Channels

Direct Contact

Direct outreach to target clients provides immediate feedback and leads. Personal interactions provide an efficient way of reaching potential customers.

Action Steps:

- Building a focused lead list of 10 target companies.
- Personalised outreach campaigns referencing each company's current or future missions and explaining how relocated debris could lower their manufacturing or launch costs.
- Offering pilot programs or proofs-of-concept to convert initial interest into first deals.

Strategic Partnerships

By partnering with credible players like established agencies, well-known manufacturers, or platforms that test new orbital technologies, we gain legitimacy.

Action Steps:

- Join forces with more advanced companies to divide work packages from space agency bids.
- Hosting private workshops or roundtables at major conferences, inviting key industry stakeholders to discuss the benefits of debris relocation and resource utilisation.
- Sign and publicise MoUs (Memorandums of Understanding) with future clients

6.2 CAC & LTV Calculations

Customer Acquisition Cost (CAC)

Acquiring customers in a niche aerospace market involves investments in specialised marketing channels, industry events, and technical demonstrations. Our primary acquisition channels are as:

Engineering as Marketing

We will focus on showcasing our innovative approach and engineering achievements. Our target customers are businesses in our industry, which means they can appreciate technical details and rigor in our materials. This approach will require an estimated £2,000 monthly budget, as we advertise our technical breakthroughs in various channels. We expect these efforts will help acquire 2 customers a year, resulting in £12,000 per customer.

Trade Shows

Participating in a premier space industry trade show (including booth fees, travel, accommodation, and marketing) will cost roughly £5,000 per event. If our presence at these trade shows results in 2 new customers, this comes to about £2,500 per customer.

Speaking Engagements

Preparing presentations, traveling to events, and producing high-quality visual materials like renders might total around £3,000 per year. If these efforts yield 2 new customers annually, that averages £1,500 per customer.

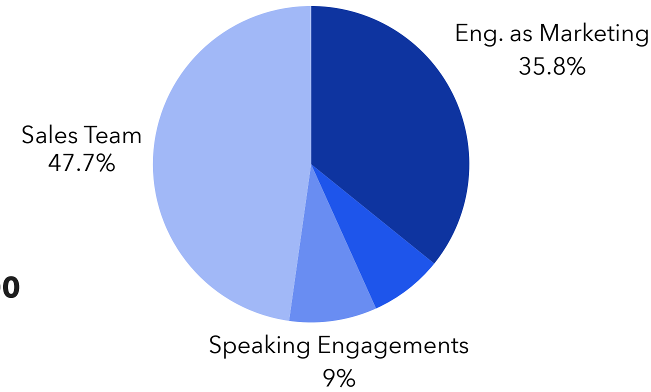
Sales Team

Our dedicated sales and customer relations and team we aim to establish after Year 3, (including salaries, commissions, and proposal development) might cost about £80,000 annually. If the team closes approximately 5 new deals each year, that's £16,000 per customer. However, this team will also run trade shows and other industry events, engaging with potential customers and develop proposal. Hence, the expensive cost per customer is justified by the integral role the sales team plays.

Combined CAC Estimate:

- Engineering as Marketing: £12,000
- Trade Shows: £2,500 per customer
- Speaking Engagements: £3,000 per customer
- Sales Team: £16,000 per customer

CAC ≈ £12,000 + £2,500 + £3,000 + £16,000 = **£33,500**



Lifetime Value (LTV)

Our LTV is based on the expected profit from each customer over the entire duration of the relationship. In the aerospace sector, customers usually engage in multi-year contracts, particularly once they integrate our debris relocation services into their long-term mission plans.

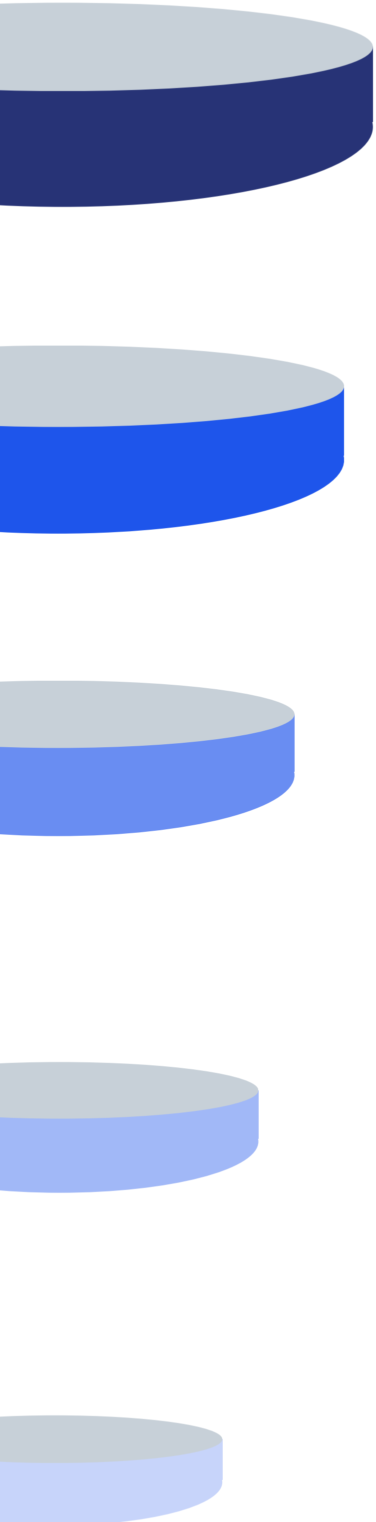
Assumptions

Annual Revenue per Customer: £200,000
This multiple small debris relocation missions bundled together.
Annual Direct Costs per Customer: £60,000
These costs include operational expenses such as mission control labour, maintenance, and data analysis.
Annual Gross Profit per Customer: £200,000 – £60,000 = £140,000
Customer Lifespan: 5 years
Given the complexity and strategic nature of space operations, we anticipate a stable, multi-year relationship with each customer.

LTV = £140,000 × 5 = **£700,000**

These metrics provide an initial baseline for evaluating the efficiency and profitability of our acquisition strategies. Over time, we will gather real data from closed deals and ongoing contracts to refine both CAC and LTV, ensuring our approach remains aligned with sustainable growth and profitability.

6.3 Sales Funnel



Awareness

Actions: Produce thought leadership content (technical whitepapers, ROI calculators for debris removal), engage in PR campaigns, and distribute educational materials at industry events.
Assumptions: A percentage of the global space debris audience will discover us through these channels.
Metrics: Website visits, initial inquiries.

Interest

Actions: Targeted outreach to satellite operators and megaconstellation managers, offer invitations to trade show demos, and send follow-up emails with in-depth service descriptions
Assumptions: A subset of the audience will actively seek more info. They'll attend webinars, read case studies, or use the interactive debris ROI tool.
Metrics: Webinar sign-ups, demo requests, email response rates

Evaluation

Actions: Host demonstrations at trade shows, schedule technical Q&A sessions with engineering teams, and share customised proposals that detail LTV, projected cost savings, and compliance benefits.
Assumptions: Of those interested, a fraction progresses to formal evaluation, comparing ReOrbit's offering with alternatives and verifying CAC and LTV assumptions.
Metrics: Number of demos completed, proposal requests, pilot program commitments

Engagement

Actions: Conduct pilot projects, provide draft contracts, and negotiate terms. Highlight partnerships, references, and case studies showing tangible ROI. Use direct sales and business development efforts to finalise terms.
Assumptions: Of the evaluators, a portion enters contract negotiations and pilot arrangements.
Metrics: Pilot agreements, letters of intent, negotiation rounds completed.

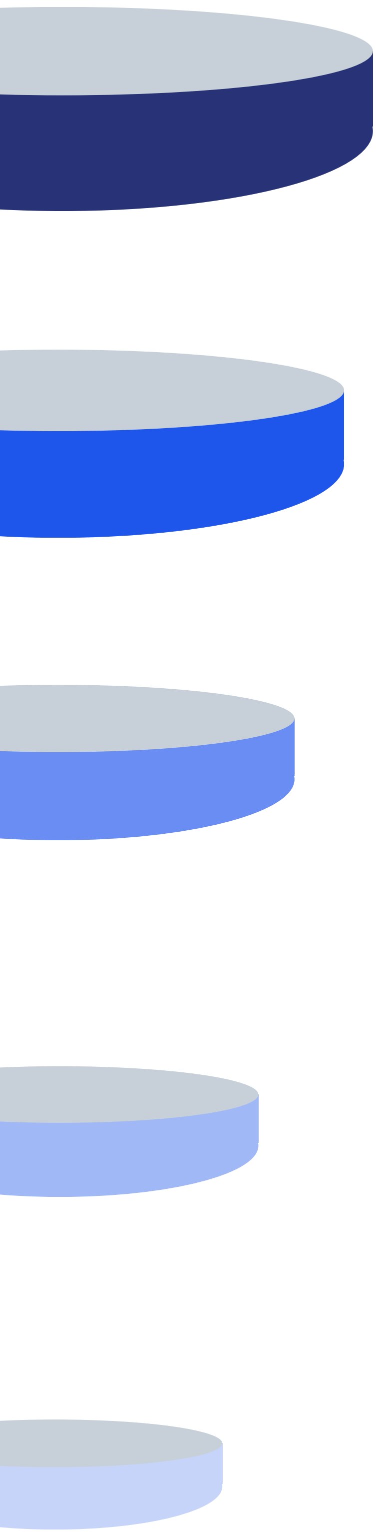
Action

Actions: Close deals with multi-year contracts. Post-sale, offer ongoing performance reports, maintenance support. Encourage referrals.
Assumptions: A certain percentage will sign contracts.
Metrics: Contracts closed, annual renewals, upsells, referrals generated.

Figure 24: Sales Funnel

6.3 Sales Funnel

Given that we are a niche market with a limited number of competitors and customers, as well as a market with high future demand, we assume that we will ultimately gain high exposure through the channels



Awareness

Actions: Produce thought leadership content (technical whitepapers, ROI calculators for debris removal), engage in PR campaigns, and distribute educational materials at industry events.
Assumptions: 98% of our serviceable obtainable market will discover us through these channels.
Metrics: Website visits, initial inquiries.

Interest

Actions: Targeted outreach to satellite operators and megaconstellation managers, offer invitations to trade show demos, and send follow-up emails with in-depth service descriptions
Assumptions: 85% of the audience will actively seek more info. They'll attend webinars, read case studies, or use the interactive debris ROI tool.
Metrics: Webinar sign-ups, demo requests, email response rates

Evaluation

Actions: Host demonstrations at trade shows, schedule technical Q&A sessions with engineering teams, and share customised proposals that detail LTV, projected cost savings, and compliance benefits.
Assumptions: Of those interested, 95% progresses to formal evaluation, comparing ReOrbit's offering with alternatives and verifying CAC and LTV assumptions.
Metrics: Number of demos completed, proposal requests, pilot program commitments

Engagement

Actions: Conduct pilot projects, provide draft contracts, and negotiate terms. Highlight partnerships, references, and case studies showing tangible ROI. Use direct sales and business development efforts to finalise terms.
Assumptions: Of the evaluators, 90% enters contract negotiations and pilot arrangements.
Metrics: Pilot agreements, letters of intent, negotiation rounds completed.

Action

Actions: Close deals with multi-year contracts. Post-sale, offer ongoing performance reports, maintenance support. Encourage referrals.
Assumptions: 70% will sign contracts.
Metrics: Contracts closed, annual renewals, upsells, referrals generated.

Figure 24: Sales Funnel

Conversion Rate: 50%

7 Assumption Framework

7.1 Assumption Ranking

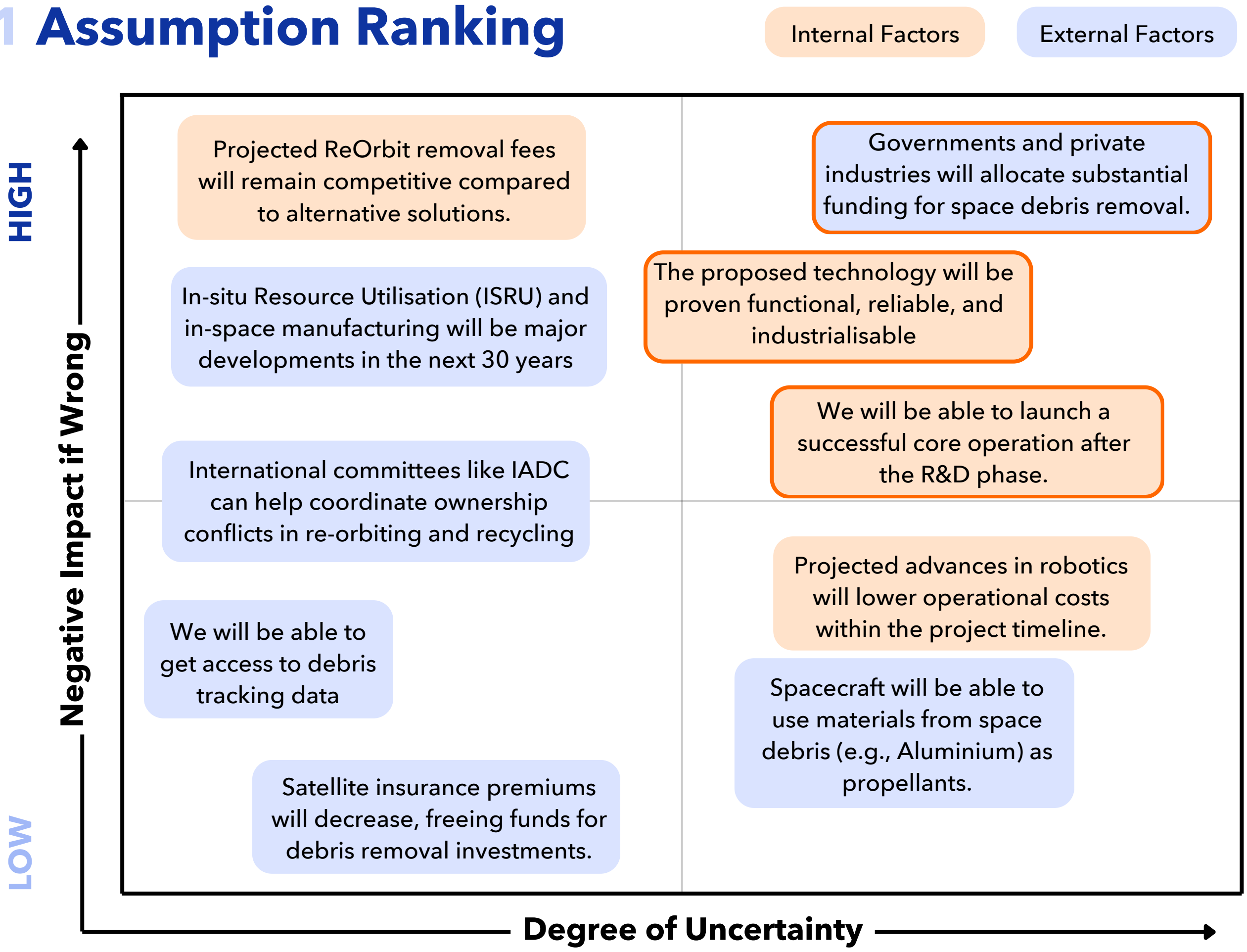


Figure 25: Assumption Framework

Ranking Rationales

LOW — HIGH

Threat to products | Threat to reputation | Immediate threat to funds

Top Three Assumptions:

Sufficient Funds for R&D

Governments and private industries will allocate substantial funding for space debris removal initiatives

- This is essential for validating core technologies, building prototypes, and ensuring readiness for initial missions

Functional, Reliable, and Industrialisable Technology

The proposed laser-based "broom" and robotic "dustpan" technologies will be proven functional, reliable, and capable of scaling to industrial levels within a reasonable timeframe

Successful Core Operation Post-R&D

ReOrbit will be able to transition from R&D to active operations, launching core services that capture and relocate debris reliably after the initial ~3-year R&D phase

- Converting R&D outcomes into tangible services is crucial for generating revenue

7.2 Validation

Funding Availability

Assumption: Governments and private industries will allocate funding over £500,000 for R&D phase
Evidence:
- **Government Documents:** History of supporting R&D for emerging space technologies. [80]
- **Expert Opinion:** Increasing willingness of agencies and VCs to fund sustainability-driven space ventures.

Mitigation Strategies:
- Seek multiple grants, approach multiple governments, and consider angel/VC investments to reduce dependency on a single-stream

Cost-Efficiency Achieved Within Five Years

Assumption: The proposed technology will attain cost-efficiency within five years of launch.
Evidence:
- **Market Research:** Comparable service-oriented aerospace companies have reached break-even points around the 4-5 year mark. For example, The Exploration Company which was founded in 2021, has achieved significant business success and raised $160 million in Series B funding [81].
- **Expert Opinion:** Learning curves and economies of scale in orbital services can become profitable within 3-7 years.

Mitigation Strategies:
- Early pilot projects to demonstrate partial revenue streams.
- Incremental improvements in efficiency through automation and AI-driven targeting

Successful Core Operation Post-R&D Phase:

Assumption: ReOrbit will be able to launch a successful core operation after completing the R&D phase
Evidence:
- **Agency's Reports:** Studies on active debris removal missions (e.g., RemoveDEBRIS [82], ClearSpace-1) show that moving from demonstration to small-scale operations can occur within a 3-5 year window.
- **Expert Opinion:** If R&D milestones are met, a small, focused operational mission is achievable by Year 3-4.

Mitigation Strategies:
- Parallel pursuit of regulatory approvals during R&D to avoid administrative delays.
- Secure pre-launch commitments or pilot agreements from early-adopter customers.
- Flexible mission design to adapt to partial successes

Experts who helped with validation:

Matvey Boguslavskiyl
Industry & Technical Validation

Neşe Önal
Financial Validation

8 Financial Framework

8.1 Profit & Loss Statements

Over three years, ReOrbit aims to transition from reliance on grants and investments to generating increasing revenue through strategic customer acquisitions. Year 1 focuses on securing initial grant funding and investments to establish operations and begin foundational R&D activities. In Year 2, the goal is to scale operations, and set up a dedicated workshop, with funding targeted through equity investments and grants to support the development for our first launch. Year 3 marks our first launch, backed by a £1M venture capital investment covering substantial expenditures for launch services, team expansion, and marketing efforts.

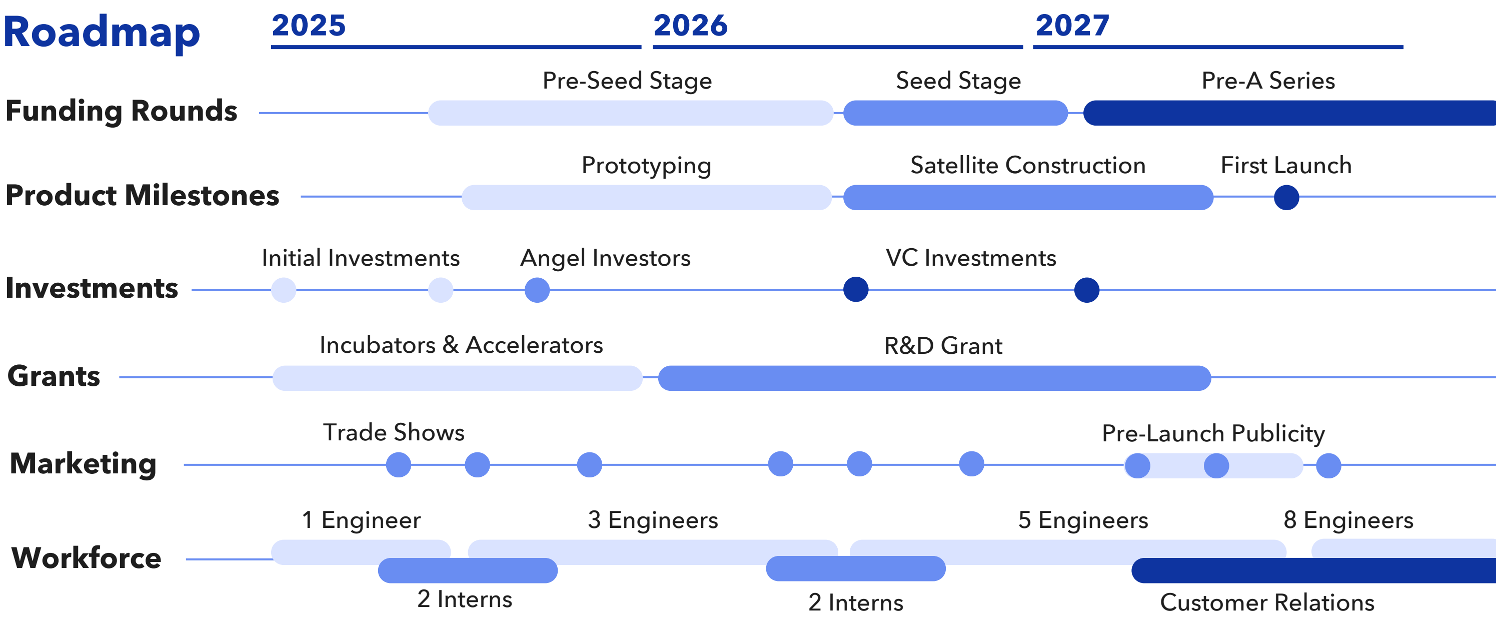


Figure 26: Roadmap

Year 1 P&L Statement

Table 1: First Year Profit & Loss Statement (in thousand GBP)

MONTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**TOTAL**
Income													
Investment	40	-	-	-	-	100	-	-	100	-	-	-	**240**
Service revenue	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Product revenue	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Grant revenue	43	-	-	-	-	26	-	-	11	-	-	15	**95**
Total income	**83**	**-**	**-**	**-**	**-**	**126**	**-**	**-**	**111**	**-**	**-**	**15**	**335**
Expenditure													
Employment costs	3.9	3.9	3.9	5.1	5.1	5.1	13.0	13.0	13.0	11.8	11.8	11.8	**101**
Consultants/Contractors	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Product costs	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Service costs	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Rent costs	0.6	0.6	0.6	0.6	0.6	0.6	0.9	0.9	0.9	0.9	0.9	0.9	**9**
R&D costs	-	-	-	-	-	-	10.0	10.0	10.0	10.0	10.0	10.0	**60**
IP costs	-	-	5.0	-	-	-	-	-	-	-	-	-	**5**
Marketing	2.0	2.0	2.8	7.0	2.0	2.0	8.1	2.0	2.0	2.0	5.3	2.0	**39**
Travel & subsistence	-	-	-	2.0	-	-	0.5	-	-	-	1.0	-	**4**
Corporate insurance	-	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5	0.5	**3**
IT costs	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	**14**
Telephone/Internet	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Accy/payroll/bank	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Legal fees	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	**12**
Capital Ex	10.0	-	-	-	-	-	50.0	-	-	-	-	-	**60**
Total Cash OUT	**18.7**	**8.7**	**14.5**	**16.9**	**9.9**	**9.9**	**85.2**	**28.6**	**28.6**	**27.4**	**31.7**	**27.4**	**308**
Net Cash Flow	63.8	- **8.7**	- **14.5**	- **16.9**	- **9.9**	116.3	- **85.2**	- **28.6**	82.6	- **27.4**	- **31.7**	- **12.4**	
Opening balance	-	63.8	55.1	40.6	23.7	13.8	130.1	44.9	16.3	98.9	71.5	39.8	
Closing balance	63.8	55.1	40.6	23.7	13.8	130.1	44.9	16.3	98.9	71.5	39.8	27.4	

Year 1 Income

Investments & Equity Funding

ReOrbit will require £40,000 as an initial investment from the founders, and £100,000 from friends and family in month 6. We aim to receive a £100,000 convertible loan investment, with the target of getting "smart money" from at least one high network angel investor. These will be converted into stake in the company by the end of the year. These phased investments ensure initial liquidity for launching operations, while also tying further funding to the achievement of key developmental milestones.

Grant Revenue

ReOrbit aims to obtain approximately £95,000 in milestone-based grants from the UK Space Agency (UKSA) and the European Space Agency (ESA). These grants are released at various points throughout the year—such as contract start, interim reviews, and final deliverable approvals—and provide financial support for early-stage R&D, prototyping, and feasibility studies [83].

Year 1 Expenses

Employment Costs

From January to March ReOrbit employs a single engineer at £3,400 per month; from April to June it retains one engineer plus two interns at £500 per intern per month, bringing monthly payroll to £4,400. Between July and September, the team grows to three engineers at £10,200 per month plus two interns at £1,000 total, resulting in £11,200 monthly, before dropping the interns for Q4, stabilizing at three engineers and £10,200 per month. 18% is added for insurance and tax costs for the business.

Rent Costs

Workshop rental and utilities cost £9,000 for the year, starting at £600 per month for the first six months and rising to £875 per month thereafter. We will rent an office the Harwell Space Cluster, and start using the shared workshops at Makeversity for £275 a month starting at Q3.

R&D Costs

ReOrbit allocates £10,000 a month to secure materials for developing and testing prototypes. By investing in tangible resources, we can rapidly iterate on designs and conduct hands-on experiments, accelerating technology validation and product refinement.

IP Costs

A one-time IP expenditure of £5,000 provides initial patent filings or related protections, safeguarding proprietary innovations from competitors and enhancing the company's long-term strategic position.

Marketing

Marketing and events have a baseline cost of £2,000 each and major spikes for the three key industry exhibitions: £5,000 for Space Symposium Colorado in April, £6,100 for Space Comm Farnborough in July, and £3,300 for Space Tech Expo Bremen in November [84]. These costs cover stands, branding, and shipping, and a one-time expense of £800 before the first event covers printing. Pricing quotes and estimations are provided and verified by the head of sales of Space Comm - Duncan Mckenzie.

Travel & Subsistence

Additional travel expenses total £4,625, covering minimal monthly allowances plus trade show attendance costs of £2,000 for Colorado, £500 for Farnborough, and £1,000 for Bremen. By keeping travel minimal, the company ensures vital in-person meetings and relationship-building occur without unnecessary luxury.

Insurance

ReOrbit spends £3,000 on corporate insurance, split between £500 per month for Q3 and Q4. Adequate coverage protects against unexpected setbacks and supports stable growth.

IT and Software

To support core operations, engineering simulations, CAD design, project management, and secure data handling, ReOrbit spends £14,400 on IT and software. Capped at £1,200 per month, this budget utilises startup discounts and minimal license tiers to ensure that essential tools are available without straining the budget.

Legal Fees

Legal support costs £12,000 for the year, at £1,000 per month, ensuring ongoing compliance with industry regulations, sound contractual agreements, and reduced legal uncertainties as the company explores partnerships and supply contracts.

Capital Expenditures

The company allocates £60,000 to capital expenditures, investing £10,000 in Month 1 and £50,000 in Month 7. These upfront equipment purchases and workshop enhancements are crucial for enabling advanced development work as the R&D program matures.

Year 2 P&L Statement

Table 2: Second Year Profit & Loss Statement (in thousand GBP)

MONTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**TOTAL**
Income													
Investment	-	-	-	-	-	-	500	-	-	-	-	-	**500**
Service revenue	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Product revenue	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Grant revenue	250	-	-	-	-	-	250	-	-	-	-	-	**500**
Total income	**250**	**-**	**-**	**-**	**-**	**-**	**750**	**-**	**-**	**-**	**-**	**-**	**1,000**
Expenditure													
Employment costs	11.8	11.8	11.8	20.9	20.9	20.9	20.9	20.9	20.9	19.7	19.7	19.7	**220**
Consultants/Contractors	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	**10**
Product costs	-	-	-	-	-	-	200.0	40.0	40.0	40.0	40.0	40.0	**400**
Service costs	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Rent costs	0.9	0.9	0.9	0.9	0.9	0.9	2.5	2.5	2.5	2.5	2.5	2.5	**20**
R&D costs	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	**194**
IP costs	-	-	-	-	-	10.0	-	-	-	-	-	-	**10**
Marketing	2.0	2.0	2.8	7.0	2.0	2.0	8.1	2.0	2.0	2.0	5.3	2.0	**39**
Travel & subsistence	-	-	-	2.0	-	-	0.5	-	-	-	1.0	-	**4**
Corporate insurance	0.5	0.5	0.5	0.5	0.5	0.5	1.2	1.2	1.2	1.2	1.2	1.2	**10**
IT costs	1.2	1.2	1.2	1.2	1.2	1.2	1.5	1.5	1.5	1.5	1.5	1.5	**16**
Telephone/Internet	-	-	-	-	-	-	0.1	0.1	0.1	0.1	0.1	0.1	**1**
Accy/payroll/bank	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Legal fees	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	**12**
Capital Ex	-	-	-	-	-	-	60.0	-	-	-	-	-	**60**
Total Cash OUT	**34.4**	**34.4**	**35.2**	**50.5**	**43.5**	**53.5**	**312.8**	**86.2**	**86.2**	**85.0**	**89.3**	**85.0**	**996**
Net Cash Flow	215.6	**-34.4**	**-35.2**	**-50.5**	**-43.5**	**-53.5**	437.2	**-86.2**	**-86.2**	**-85.0**	**-89.3**	**-85.0**	
Opening balance	14.2	229.8	195.4	160.2	109.7	66.2	12.7	449.9	363.7	277.5	192.5	103.2	
Closing balance	229.8	195.4	160.2	109.7	66.2	12.7	449.9	363.7	277.5	192.5	103.2	18.2	

Year 2 Income

Investment & Equity Funding

We start our next funding round in Q3, aiming for a £500,000 injection from a venture capital or multiple angel investors, in the form of a convertible loan. This will underpin the £1.5M funding round we plan for Q1 of 2027 with a pre money valuation of £10M. This crucial loan will help set up our own dedicated workshop space, offering the capital to sustain this acceleration.

Grant Revenue

ReOrbit aims to secure an R&D grant worth £750,000, paid in 3 installments over 18 months. The first payment in January provides crucial liquidity, ensuring that initial R&D and setup costs are manageable. The second payment in July arrives at a pivotal time as we transition to our dedicated workshop.

Year 2 Expenses

Employment Costs

We aim to hire 2 more full-time employees in Q3, to help build the satellites to be launched for the demo mission. Like last year, we will also hire 2 interns for 6 month placements, to help with the crucical step of moving operations to our workshop.

Consultants/Contractors

As ReOrbit scales up, we allocate a £800 monthly budget for consultants and constructors. These outside specialists supplement in-house capabilities, offering advisory as needed. We will also receive mentorship and technical expertise from our angel investors that have invested in ReOrbit so far.

Product Costs

Q3 marks the beginning of a 12 month process of building and testing our first satellites for a launch in Q4 of 2027. The budget for this process is £640,000, with £200,000 initial spending and £40,000 each month to refine prototypes, scale testing, and prepare for the demo mission.

Rent Costs

Cost of rent increases to £2,500 a month as we move to a workshop in Harwell Space Cluster, and start operating from the new workshop.

R&D Costs

The monthly spending for R&D increases by £6,200, as we prepare to start building our satellites in Q3.

IP Costs

A one-time £10,000 intellectual property expense in June secures final patents before we start building our satellites, safeguarding our innovations from future competitors.

Marketing

Marketing costs remain the same as we attend the same trade shows as the year before.

Travel & Subsistence

Travel costs remain the same as we travel to the same trade shows as the year before.

Corporate Insurance

Corporate insurance costs rise from £500 per month initially to £1,200 per month after July's operational scale-up, totaling £10,200 over the year.

IT Costs

IT expenditures start at £1,200 per month and increase to £1,500 per month from Q3 as ReOrbit moves to its own workshop.

Telephone & Internet

A fee of £100 a month is paid for telephone and internet of the new workshop from Q3

Legal Fees

Budget for legal fees remains at £1,000 a month.

Capital Expenditure

In July, we invest £60,000 capital expenditure to secure equipment and prepare the workshop.

Year 3 P&L Statement

Table 3: Third Year Profit & Loss Statement (in thousand GBP)

MONTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Income													
Investment	-	1,000	-	-	-	-	-	-	-	-	-	-	**1,000**
Service revenue	-	-	-	400	-	-	200	-	-	-	400	-	**0**
Product revenue	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Grant revenue	250	-	-	-	-	-	-	-	-	-	-	-	**250**
Total income	**250**	**1,000**	**-**	**400**	**-**	**-**	**200**	**-**	**-**	**-**	**400**	**-**	**2,250**
Expenditure													
Employment costs	19.7	19.7	19.7	21.9	21.9	21.9	21.9	21.9	21.9	21.9	32.7	32.7	**278**
Consultants/Contractors	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	1.6	1.6	**11**
Product costs	40.0	40.0	40.0	40.0	40.0	40.0	-	-	-	-	-	-	**240**
Service costs	-	-	-	-	-	-	-	-	20.0	720.0	-	-	**740**
Rent costs	0.9	0.9	0.9	0.9	0.9	0.9	2.5	2.5	2.5	2.5	2.5	2.5	**20**
R&D costs	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	32.0	32.0	**226**
IP costs	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Marketing	2.0	2.0	2.8	9.0	4.0	4.0	10.1	4.0	4.0	2.0	5.3	2.0	**51**
Travel & subsistence	-	-	-	2.0	-	-	0.5	-	3.0	-	1.0	-	**7**
Corporate insurance	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	33.2	1.2	1.2	**46**
IT costs	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2.5	**20**
Telephone/Internet	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	**1**
Accy/payroll/bank	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Legal fees	1.0	1.0	51.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.6	1.6	**63**
Capital Ex	-	-	-	-	-	-	-	-	-	-	50.0	-	**50**
Total Cash OUT	**83.4**	**83.4**	**134.2**	**94.6**	**87.6**	**87.6**	**55.8**	**49.2**	**72.2**	**799.2**	**130.5**	**76.2**	**1,754**
Net Cash Flow	166.6	916.6	- **134.2**	305.4	- **87.6**	- **87.6**	144.2	- **49.2**	- **72.2**	- **799.2**	269.5	- **76.2**	
Opening balance	14.2	180.8	1,097.4	963.2	1,268.6	1,181.0	1,093.4	1,237.6	1,188.4	1,116.2	317.0	586.5	
Closing balance	180.8	1,097.4	963.2	1,268.6	1,181.0	1,093.4	1,237.6	1,188.4	1,116.2	317.0	586.5	510.3	

Year 3 Income

Investment & Equity Funding

In Q1, we aim to receive £1,000,000 in venture capital funding, marking a significant milestone for our growth. This investment underpins major operational expansions, including team growth and preparation for the upcoming launch in October.

Service Revenue

We begin to sign our first contracts with customers acquired from trade shows. We reach the significantly larger market in the US through the Space Symposium Colorado in April, and the impact of our successful launch generates a higher interest in Space Tech Bremen in November.

Grant Revenue

The third and final payment of our R&D grant from the previous year provides crucial liquidity as we reach the end of our first development process.

Year 3 Expenses

Employment Costs

We will hire a full-time Customer Relations Associate as we begin to sign deals with customers in Q2. We also aim to hire 3 new engineers post-launch, aiming for consistent growth in the future.

Consultants/Contractors

Consultancy budget remains steady at £800 per month until Q4, when we aim to double the budget to accomodate growth after a successful launch.

Product Costs

Product costs remains at £40,000 for the first 6 months, as we finish building our satellites.

Service Costs

Using the SpaceX rideshare program, we are able to launch our satellites for £720,000 in October. This estimation is based on the weight and size of the two satellites we will launch in our demo mission [82].

Rent Costs

Rent costs remain the same as we keep operating from our workshop in Harwell Space Cluster.

R&D Costs

We aim to increase the R&D spending to £32,000 a month in November, reflecting the intensified focus on post-launch developments and technical refinement.

Marketing

Marketing efforts increased for the 6 months before launch as we ramped up activities for customer acquisition and launch promotion.

Travel & Subsistence

Travel expenses increase by £3,000 in October as the core team travels to the launch site for final assembly, tests, and mission control.

Corporate Insurance

In addition to the base rate, an insurance cost of £32,000 occurs in October, which will cover the £640,000 spending on satellite construction in case of an accident [82].

IT Costs

We aim to invest in better software after a successful launch, increasing the IT costs by £1,000 a month.

Legal Fees
Legal fees spike in Q1 with a one-time payment of £50k, covering critical contracts and agreements for the rights to collect and relocate space debris belonging to various companies and space agencies.

Capital Expenditure
A £50k capital expenditure was incurred in November, supporting infrastructure and equipment upgrades for post-launch activities.

Figure 24: Trade Show Booth Mockup

8.2 Evaluating Financial Forecasts

We have discussed the feasibility of our funding goals and the details of our P&L statements with an expert, to gain insights on the financial future of ReOrbit. We evaluated possible funding opportunities, refined our roadmap, and reviewed our assumptions.

Neşe Önal
Economist, Angel Investor
Venture Capitalist at VINCI

Year 1
ReOrbit will require at least 3 co-founders, two with technical backgrounds and one focusing on business development and financing. The technical co-founders will lead R&D projects, evaluate feasibility, and set up the workshop, while the other co-founder values the company, secures funding, and works on accounting. A well balanced founder profile is crucial for success in early stages.

Year 2
Our biggest cost on Year 2 will be the product costs of constructing a satellite, starting in Q3. Deviations from our estimations in this area may result in significant increase or decrease in costs. A significant increase in costs in Q4 would be the most threatening for our finantial situation, as we are left with £18,000 before the final payment of the R&D grant.

Year 3

We will receive our biggest investment so far in Q1 of 2027. Such large-scale investors would like to know how their investment capital is spent. We will rely on our co-founders background in business and finance for financial management. We also assume interest rate incomes will cover the banking commissions, hence they are not shown in the financial statements. Our largest expense yet will be the initial launch in October, however we expect to have the cash necessary cover up to 44% higher costs in this area.

Moving Forward

We have evaluated 3 different paths ReOrbit can take after 2027. All paths assume ReOrbit has successfully completed its 3 year plan.

Further Funding

We will keep receiving investments from larger VC's and keep scaling operations. Once profits are stable, ReOrbit can start paying dividends to shareholder, attracting more investors. Eventually, a major private equity acquisition can shift management structures in the company.

Public Ownership

A possible option after stabilising profits and reaching our targeted market capture would be to IPO and transition into a publicly traded company. This will generate necessary capital for future growth without having to include new stakeholders in the management team.

Full Acquisition

ReOrbit can be strategically acquired by a space agency or a larger aerospace company. A company that benefits from our service can utilise our IP rights and satellites to gain significant market advantage.

8.3 Best & Worst Case Scenarios

Best Case Scenario

In the best-case scenario, the company swiftly obtains regulatory permissions, completes its demo mission under budget and on schedule, and confirms the technical and commercial feasibility of its debris relocation service. This success attracts additional investor interest and secures contracts with customers. Strong market adoption, investor confidence, and the ability to reinvest in R&D lead to sustained growth, a stable cash flow, and a strengthened competitive position in the orbital services market.

Worst Case Scenario

In the worst-case scenario, the company encounters delays and cost overruns due to complex regulatory hurdles and technical challenges in executing the demo mission. A possible problem during feasibility studies may delay in R&D. Uncertain timelines and ballooning expenses erode investor confidence and make securing follow-on funding difficult. Without profitable contracts or reliable revenue, the firm burns through its reserves, ultimately facing insolvency and the need to sell off intellectual property or cease operations before its service can gain market traction.