

# FILLING THE TOOLBOX WHILE DEFINING THE JOB

## PRODUCT MANAGEMENT AT CLEARSPACE

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### ABSTRACT

This paper presents an approach to product management applied to a scaling In-Orbit Servicing (IOS) organisation, encompassing activities like end-of-life disposal, active debris removal, object inspection, orbit maintenance, life extension, refuelling, manipulation and repair. All of which demand a well-coordinated blend of technological innovation, regulatory compliance, and market alignment [5].

At ClearSpace we implement our corporate strategy by means of offering a curated and resilient suite of services tailored to the emerging In-Orbit Servicing (IOS) market use cases. To enable those services, we develop cutting-edge capabilities besides more traditional space system building blocks required and available. This paper will highlight services we've identified, along with the key enabling capabilities behind them. We've found that many capabilities can be applied across multiple services.

Through a top-down methodology, the study explores how aligning company strategy with technology roadmaps fosters innovation and operational efficiency.

The analysis synthesizes insights from leading industry reports, international standards, and best practices, proposing a robust framework to translate high-level strategic objectives into detailed, executable technological initiatives. This work aims to contribute to the discourse on space sustainability and resilience through advanced IOS capabilities while ensuring commercial opportunities for a nascent industry that brings the disruptive technology required to change the paradigm.

### 1 VISION AND STRATEGY

ClearSpace is leading the charge by bringing services to orbit with the highest market impact. Founded in Switzerland in 2018, we are at the forefront of developing innovative technologies enabling a circular space economy. We make space operations safer, more reliable and sustainable.

ClearSpace achieves those goals by means of implementing a corporate strategy of market access, which remains compliant to international guidelines and best practices [2,4,6].

This strategy is defined as:

1. Move **fast**
2. **Only** create technology that does not exist
3. Robust and flexible to **change**
4. Use the right **partners**
5. Re-use of common **building blocks**.

### 2 PRODUCT MANAGEMENT

#### 2.1 Top-Down vs Bottom-Up

By adopting a top-down approach, product owners translate corporate strategic objectives into detailed technological initiatives, effectively guiding R&D investments and operational execution. This approach not only ensures alignment between business objectives and technological milestones but also supports agile adaptation to evolving market and regulatory landscapes.

The chosen service to technology top-down flow is as follows:

- Strategy dictates services to be developed
- The services require enabling capabilities
- Capabilities ensured by identified technology
- Roadmaps created (scope, cost and schedule)

There exists an element of bottom up in the product management as well. As ClearSpace is partially funded through contracts with institutional anchor clients, and these projects yield technology as their nature is to mature and demonstrate technology. There exists a continuous cross-check between the projects feeding our technology roadmaps and how this remains well-aligned to the services under development.

#### 2.2 Services

Services are the things we sell to clients. ClearSpace maintains a vision of services and their use cases where high margin market opportunity exists.

Services are not static, as there are uncertainties on the knowledge which services are sought after, by whom and their respective funding constraints. A product management process is in place that allows **flexibility** and **robustness** to changing market parameters.

The company strategy led to the selection of 3 main services including two example use cases alongside it:

- Disposal
  - o Removal of defunct objects
  - o Outsourced end-of-life manoeuvres
- Inspection
  - o Check for state, damage, degradation
  - o Protect sovereign space assets
- Orbit Maintenance
  - o Station keeping
  - o Attitude management
  - o Extended revenue stream.



Figure 1. Disposal



Figure 2. Inspection



Figure 3. Orbit Maintenance

The initial services pave the way to more complex in orbit services in by adding distinct additional capabilities such as refuelling (conops and mechanism to transfer fluids) and manipulation (replacing components or repairing structures).

### 2.3 Capabilities

Capabilities are defined as a set of technologies that ClearSpace product owners, whom are also our technical leads, develop towards. Services are combined from multiple abstract capabilities, which are divided into product groups. Starting with the latter, product groups are where we host ownership of capabilities and technologies. Below are the product groups introduced

with their main tasks.

#### Product Groups defined

- Mission Design and Operations
  - o Service delivery
  - o System engineering
  - o Mission analysis
  - o Planning, command and control.
- Guidance Navigation & Control (GNC)
  - o Absolute and relative navigation
  - o Navigation and Control algorithms
  - o Select sensors.
- Robotics
  - o Kinematic and grasp analysis
  - o Mechanical assemblies development
  - o High and low level control software.

In the same product groups, we have identified the following capabilities

#### Capabilities assigned

- Mission Design and Operations
  - o Design robust missions
  - o Operate securely and safely.
- Guidance Navigation & Control (GNC)
  - o Find and identify objects
  - o Move around and approach safely.
- Robotics
  - o Capture accurately
  - o Secure tightly.

The central question driving our approach is: ‘Will our decision and selections help ClearSpace advance, launch and be successful?’

### 2.4 Technology

Technologies enable capabilities, which are used to deliver services. We make sure we only build what is not for sale yet, as we have the objective to move fast. Our make-or-buy decision-making process is rigorous and strict. To avoid a pure in-house make at all costs, we make use of buy in the form of commercially available components (COTS), built-to-specification and built-to-print. All in the name of focusing on a select set of core technologies which are key, and implement those in exceptional quality, ensuring safe execution of our mission goals. This paper only list technologies that we create in-house.

The implementation of selected technologies requires a detailed understanding of orbital mechanics, material science, autonomous control systems (reduced latency allowing higher precision) and how these aspects impact the larger system. For instance, path planning of relative motion and robotic assemblies should take place to execute complex capture operations with minimal risk of creating additional debris.

In the same product groups as capabilities are listed,

ClearSpace identified technology gaps and fills them through preparing and executing technology roadmaps.

#### Technology identified

- Mission Design and Operations
  - o Mission and System Tools
  - o Common Ground Segment.
- Guidance Navigation & Control (GNC)
  - o Relative navigation suite.
- Robotics
  - o Docking and capture systems
  - o Robotic arm and end effectors.

Key technologies identified above are in some cases created from ClearSpace's ongoing demonstration and technology maturation projects. But it is key to recognise the element of designing technology with maximum re-use in mind, for example applying CONFERS [4] best practices despite not being contractually required. ClearSpace product owners are therefore in close contact with the internal system architects and project managers. Under guidance of the Chief Technology Officer, decisions are made on how technology is implemented in full support to the roadmap, feeding capabilities and services while still fulfilling the ongoing projects.

### 3 IMPLEMENTATION

#### 3.1 Roadmap

Technology roadmaps are instrumental in achieving strategic objectives. ClearSpace technology leadership establishes clear milestones in technology roadmaps, which are coordinated between cross-functional teams, including programmatic, engineering, and regulatory compliance. In the organisation, agile methodologies are utilised to adapt to challenges, opportunities and integrating test feedback into design improvements. Roadmaps contain timelines, resource allocation and are subject to risk management strategies.

The roadmaps outline the technological maturation from concept, through research and development, prototyping, testing, and deployment. A good roadmap ensures modularity, scalability, and through compliance with standards such as ISO 24330 [2] it reduces technical risk. By incorporating emerging technologies like integrated guidance navigation and control with robotics, autonomous diagnostics and responses, and advanced propulsion systems, ClearSpace is preparing itself for the future.

#### 3.2 Operational Efficiency

Company operations of scale-ups such as ClearSpace must be very balanced. Reducing the amount of development we want to take in house, makes us move fast.

The building blocks re-use approach enables ClearSpace to be effective in implementing a LEGO®-like architecture, that is comparable to an earthbound solution which can brush, sweep, push, blow, vacuum all on the basis of a consistent framework and modular technology roadmap execution.



Figure 4. Multi service modularity (credit: LM-Trac)

### 4 PARTNERSHIPS

ClearSpace will keep voicing the need for strong partnerships with commercial partners and research institutions to accelerate the maturation of early-stage technologies at low Technology Readiness Levels (TRL). ClearSpace considers opportunities at technology maturation, such as hosted payloads on other missions as well as uploading flight software to spaceborne platforms with representative hardware infrastructure.

Also, regarding the virtue of only building what we must (and buy what we can), ClearSpace is constantly looking for partners that help us advance and fly faster.

### 5 REFERENCES

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