bright ascension

# UNLOCKING THE $1T OPPORTUNITY:

## SOLVING FRAGMENTATION IN THE SPACE SUPPLY CHAIN

**WHITE PAPER**



HELiX
SOFTWARE INTEGRAL TO SPACE

## EXECUTIVE SUMMARY

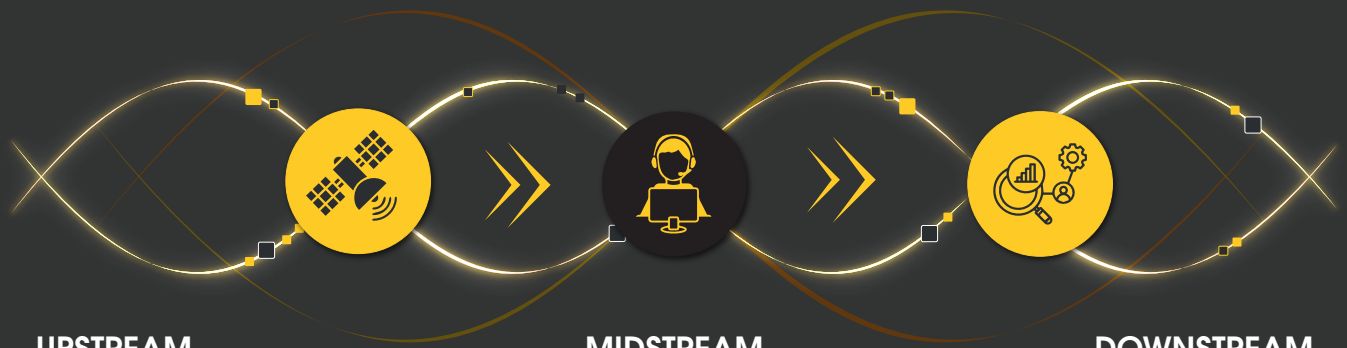
The global space industry is experiencing robust, demand driven growth, with commercial applications now dominating sector value and pushing the market toward a projected **$1T milestone before 2032**. Yet, despite this momentum, the industry faces structural barriers that limit its ability to fully meet downstream needs. Chief among these are fragmentation and siloing across the supply chain, driven by diverse technologies, bespoke software requirements, limited standardisation, and increasingly complex mission architectures. These factors collectively restrict scalability, interoperability, security, efficiency and long term maintainability, raising total cost of ownership and slowing time-to-market for new services.

Whilst innovations such as AI, software-defined systems, novel mission architectures, and cloud technologies add value within individual silos, they do little to address the end-to-end structural challenges preventing cohesive growth. Vertical integration offers coherence but encourages shallow optimisation. This produces solutions that are internally elegant but ultimately settle at a local optimum, creating fragility and often excluding better external innovations.

Bright Ascension's **HELIX technology** directly tackles these issues by providing a modular, open, information-rich software infrastructure that harmonises diverse hardware and software, enabling **flexible, scalable systems-of-systems without reducing industry diversity**. Acting as both infrastructure and a platform for mission-specific capabilities, HELIX supports piecemeal adoption while strengthening interoperability and reducing integration friction across the supply chain.

By enabling the industry to overcome fragmentation while preserving its innovative diversity, HELIX provides a credible path to unlocking downstream demand and achieving the next era of sustainable growth.

## GLOBAL SPACE INDUSTRY STRUCTURE



**UPSTREAM**

Developing and operating space systems

**MIDSTREAM**

Delivering and managing space-based services

**DOWNSTREAM**

Using space services to provide insights and applications

## DEMAND DRIVEN GROWTH

The space industry hit a record size in **2025**, reaching **$613B** with an annual growth of nearly 8%. This growth is driven by a broad range of commercial and government applications, with commercial revenues representing **nearly 80%** of the global space economy. All expectations are that this growth will continue, with the space sector expected to be worth **$1T before 2032**.

Application growth demonstrates the real demand for space-enabled services, across a diverse range of sectors from agriculture and environmental monitoring to logistics and insurance. In the UK, the UK Space Agency has estimated that as much as **18% of the country's GDP** is dependent on the space industry. The demand for space data is clearly there, if it can be provided in the right ways, at the right price and at the right time.

## PROJECTED SPACE INDUSTRY GROWTH




## RISING TO THE CHALLENGE

Attempting to meet this demand from the non-space economy has driven major innovations in the upstream space industry, including:

- Scaling the space segment to **constellations**, both small (up to 50 satellites) and large (50+), even without considering mega-constellations.
- Increasing the capabilities and complexity of data-gathering payloads, from **hyperspectral imagery to synthetic aperture radar**.
- Leveraging a wider range of terrestrial technologies to put more **high-performance computing** into space and enable **satellite-based data processing**.

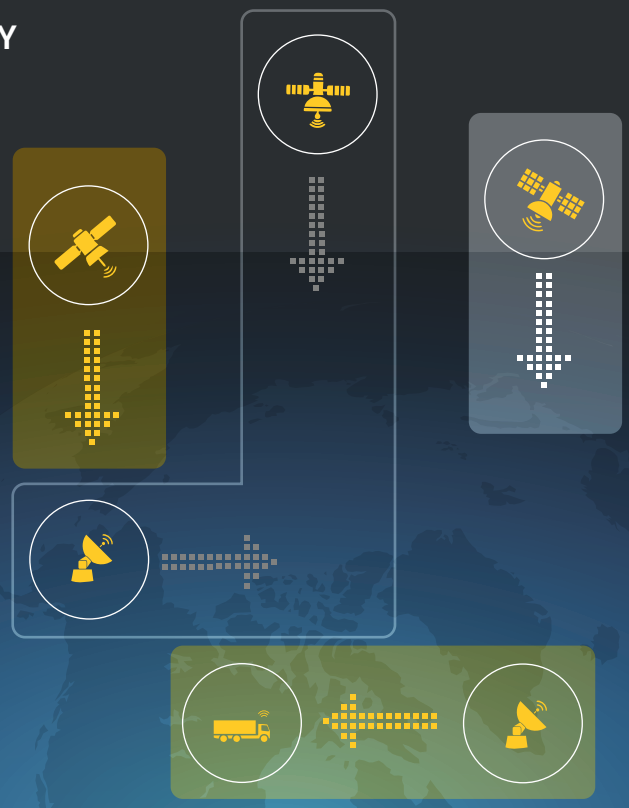
To support this increase in complexity, the industry has developed a wide ecosystem of specialist companies with the ultimate delivery of space-based services, data, analytics and insights driven through supply chains to the downstream consumer.

## THE POWER OF SUPPLY CHAINS

Space supply chains are an industry super-power: they permit **diversity** and promote **rapid organic growth** within the industry through a low barrier to entry and an absence of monopoly players. This fosters a vibrant market for solutions, with few technology constraints driving rapid innovation.

## FRAGMENTATION OF SPACE INDUSTRY SUPPLY CHAIN

Across the upstream, midstream, and downstream segments, solutions remain **highly fragmented**, leading to inefficiencies across the supply chain. While pockets of standardisation exist, their limited scope prevents broader alignment and constrains scalability and operational efficiency.



Whilst this diversity breeds novel solutions, it also naturally results in fragmentation within supply chains and the emergence of technology silos. Standardisation within the space industry has been focused on critical **interfaces**, the sources of very specific challenges, such as **secondary launch payloads** (the CubeSat standard) or **spacecraft/ground station communications** (CCSDS space link standards).

Whilst valuable, standardisation has not spread more widely within the supply chain, partly because of the very fragmentation which would benefit from it. It is notable that the most widely adopted standards have emerged from outside of the commercial landscape: the CubeSat standard came from academia, and CCSDS is an inter-agency body with limited commercial representation. In this environment, it is difficult to imagine the organic emergence of widespread standards, especially those that would not stifle innovation.

## IMPACTS OF SUPPLY CHAIN FRAGMENTATION

Fragmentation and siloing within the upstream to downstream supply chain creates many second-order effects, each of which generates its own pain points for industry players. **Software plays a critical role** in these supply chains and is often the element most impacted by the secondary effects of fragmentation, and the most relied upon to mitigate these effects.

### BESPOKE SOLUTIONS NEEDS

Technological diversity, and a lack of commercial off-the-shelf solutions means that creating a new application for space data or services typically requires the creation of **bespoke software**. This need is not just to incorporate **new techniques, analyses and algorithms** but also to **integrate** applications with data sources or providers of key space-based services such as narrow band communications. This need is replicated further up the supply chain, for **operational control, data processing** and **data distribution**. From an industry perspective, an overreliance on bespoke software is inefficient, reduces time to market for new ideas and limits innovation.

### SCALABILITY

The points of interaction between silos in the supply chain act as bottlenecks which prevent efficient scaling. Barriers to scaling come from challenges in two key areas: **control** and **data**. On the control side, managing large, interconnected systems-of-systems is **complex and difficult to coordinate**. As systems scale, and age, they will tend to become more diverse, exacerbating the control challenge. On the data side, it is challenging to combine and fuse information from diverse sources in a way that produces **meaningful insights**. Scaling within a given silo is feasible, but ultimately faces restrictions at the points of interaction from the volume, structure and complexity of interactions.



***Software plays a critical role in these supply chains and is often the element most impacted by the secondary effects of fragmentation, and the most relied upon to mitigate these effects.***

### INTEROPERABILITY

The points at which fragmented elements of the supply chain interact are obviously key pain points for inter-operability. The **limited availability of standards** creates a new and frequently unique challenge at each interaction point. Whilst technologies used for interaction, such as standard protocols, messaging technologies, API technologies etc. are one part of the puzzle, by far the greater issue is the **semantics** of these interactions. The meaning of operations across a silo boundary are typically complex, reliant on an understanding of the industry-specific context, and very challenging to capture in a formal way. This frequently leads to, often subtle, ambiguities, driving further challenges in efficiency, security and maintainability. For example, an API may provide information about the `availability' of an asset, such as a satellite or ground station but the precise meaning of `availability' may vary depending on provider leading to challenges in using this information for automated scheduling. This kind of loss of semantics frequently leads to, often subtle, ambiguities, driving further challenges in efficiency, security and maintainability.

### EFFICIENCY

Where control or data passes the points of interaction between silos there is inevitably a **loss of information, meaning or context**. This loss of information gives rise to localised decision-making based on **insufficient context** resulting in less-than-optimal outcomes when considered from an end-to-end perspective.

### SECURITY

Supply chain fragmentation creates a high surface area for security. Every interaction point between silos is a potential security **weak point**. Diverse environments across the supply chain make taking a consistent approach to security very challenging, with many different technologies and security models in use. Ensuring a secure system by design in these circumstances is extremely challenging, and increasingly important for both commercial and government end users.

### MAINTAINABILITY AND ADAPTABILITY

Diversity of technology and approach across the various fragments of a typical supply chain does not only pose challenges for the static system but additionally creates challenges in how those systems **change over time**. The lack of coordination means that the operation of system across silo boundaries can be extremely fragile in the face of change, whether that be routine maintenance or longer-term adaptation to a shift in needs and market conditions.

*Putting these various issues together, **higher costs** are created across both the **end-to-end system** and its **operational life cycle**. These costs are borne by each organisation in the supply chain as total cost of ownership and limit the profitability and therefore viability of potential solutions, ultimately limiting the capability of the industry to meet downstream application needs.*

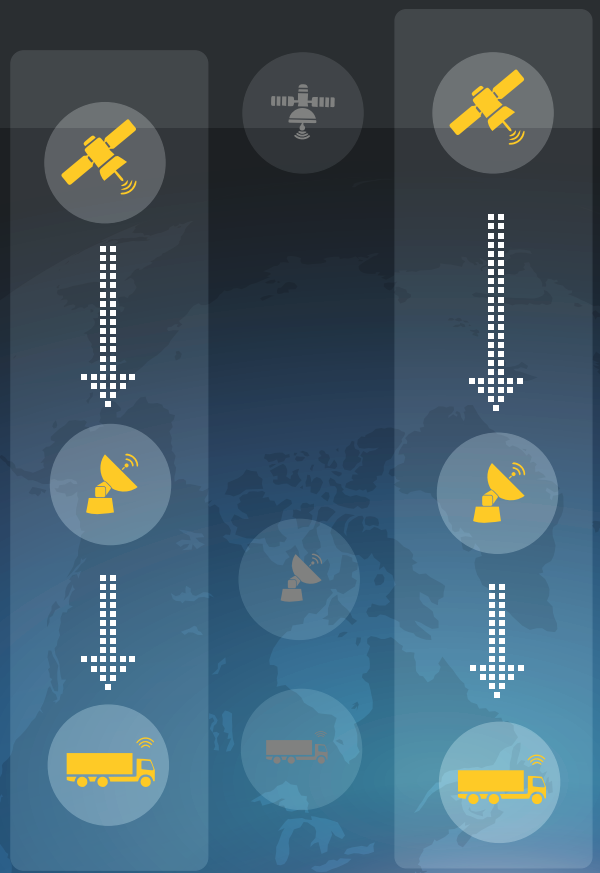
## MONOCULTURAL FRAGILITY OF VERTICAL INTEGRATION

One way of mitigating issues derived from fragmentation and siloing is to bring the complete value chain, from upstream to downstream, under the control of a single organisation. By greatly simplifying a diverse supply chain, this creates a coherency which limits the demands on interfaces and often increases efficiency. For example, an Earth observation company may provide specialised insights to the maritime sector derived from its own data products which have been acquired from satellites in a constellation which it has built and continues to operate.

## VERTICALLY INTEGRATED SUPPLY CHAIN

Vertical integration can simplify the supply chain by putting everything under one organisation, but it also creates new problems. It can make companies **less flexible** and more **vulnerable to change**, as they rely on a single, tightly controlled system.

By limiting collaboration and outside innovation, it can lead to **narrow solutions** that don't adapt well to new needs. As a result, vertically integrated approaches risk slowing progress or becoming outdated in a fast-moving industry.



However, in a rapidly changing market, this coherency can easily create **fragility**. The monocultural environment of a vertically integrated approach may benefit a specific application, but for the broader industry it creates **siloing of its own**, through shallow solutions which constrain wider applications and fail to benefit from innovations driven by diversity in the sector. Vertical integrations therefore run the risk of either holding the industry back and constraining the ability of organisations of all kinds to meet new and emerging demands, or of failing to meet key needs and passing into irrelevance, an opportunity wasted.

## RECOGNISING FRAGMENTATION AND SILOING

How well recognised are these issues?

The root causes of much of the fragmentation we see in the market draw on historic perspectives in the industry, such as **the divide** between *flight* and *ground* systems, *mission* and *service* operations, *upstream* and *downstream*. Whilst integration challenges at these specific points are frequently acknowledged, the global problem is under-recognised as relatively independent stakeholders have no requirement to assess or take responsibility for a **complete supply chain**.

Perhaps the sole exception to this is in **Nation Security and Defence** (NS&D) applications, where the end-to-end perspective of the ultimate government customer, coupled with a diverse supply chain, encourages a clear recognition of the role that infrastructure can play in achieving secure and efficient systems.

Outside of NS&D, this widespread under-recognition is leading to the emergence of fragmentation and siloing as **fundamental barriers** to industry growth, limiting the ability of the space ecosystem to meet downstream demands rather than encountering any lack of demand for space-derived services from outside the core industry. To continue the growth success story of the last decade into the next, addressing these core concerns is paramount.



***One sole exception is National Security and Defence (NS&D), where the government's end-to-end perspective and diverse supply chain support clear recognition of infrastructure's role in secure, efficient systems.***

## DEEP TECH TO THE RESCUE?

Software technology innovations are being applied at scale across a wide range of applications, completely independently of sector. Unsurprisingly, the space industry is drawing on many of these new technologies to offer novel services and capabilities. Given their positive role, it is worth turning attention to whether any new software technologies can help in addressing challenges derived from fragmentation and siloing in the space supply chain.

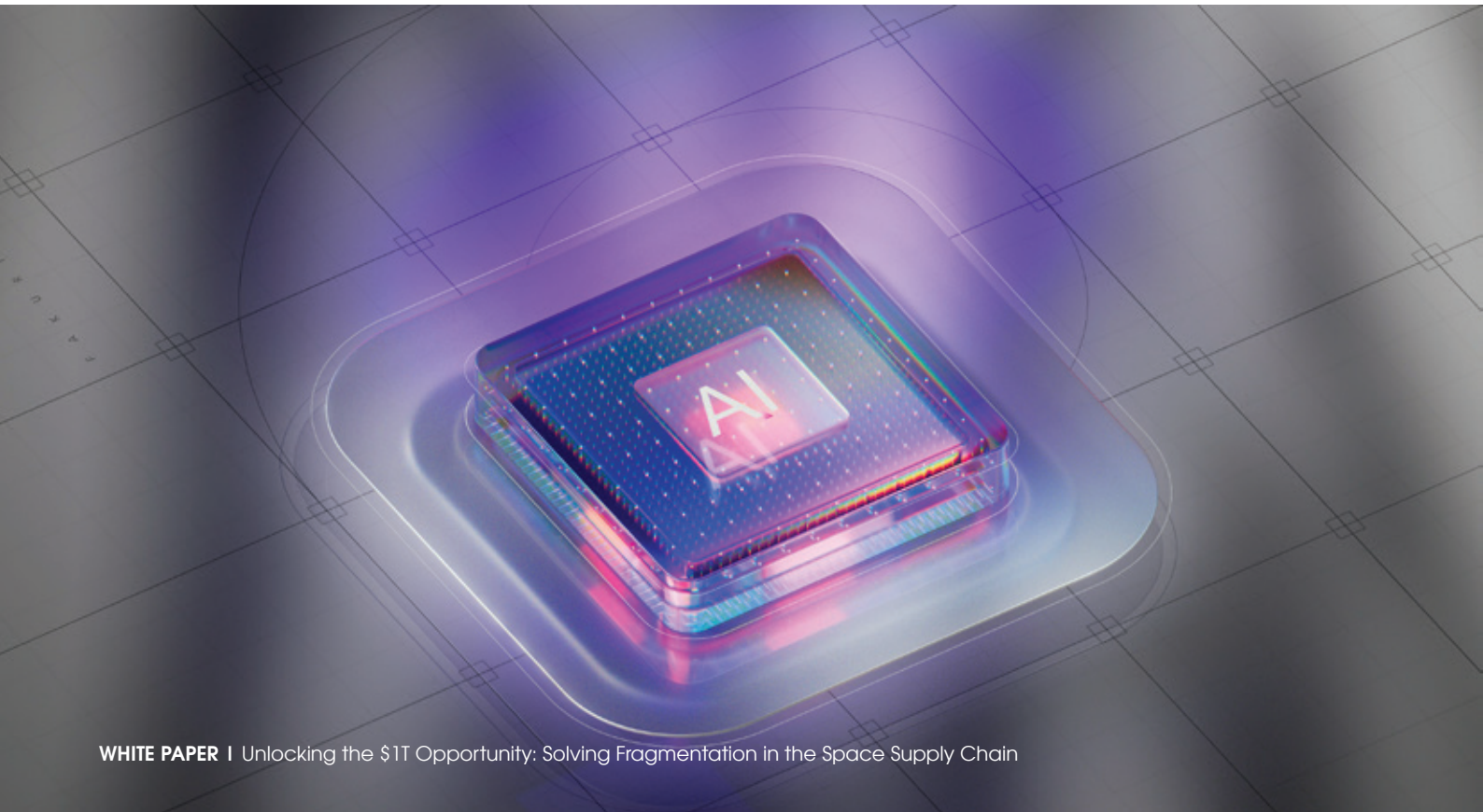
### ARTIFICIAL INTELLIGENCE

The current popularity of the umbrella term Artificial Intelligence (AI) does a disservice to the diversity of technologies usually grouped under that label. The space industry has been a beneficiary of AI technology for some time, especially in the realm of **data processing** where **machine learning** (ML) approaches are frequently applied to derive more informative value from data products and reduce the time necessary to create actionable insights.

The flexibility of ML means that the industry is likely to be only scratching the surface, especially when considering the potential for applying ML within the context of more **complex mission architectures**.

The application of more recent **generative AI** technologies to the industry has shown promise in specific areas around **development productivity** and the **accessibility of analytics**.

However, the widespread applicability of GenAI is currently unproven, especially at scale and over time. Furthermore, whilst both the use of ML and GenAI has demonstrated their value at specific stages in a supply chain, there is no indication that any AI technology offers potential solutions to end-to-end fragmentation challenges.



## SOFTWARE-DEFINED SYSTEMS

The recent history of the space industry has consistently seen two key trends: **commodification of hardware** and a steady increase in the **computing resources** available for software.

These two forces combine to encourage a shift in where the value of space system lies, **from hardware towards software**. A significant benefit of this is flexibility: software is obviously easier to modify than hardware, permitting space systems to better adapt to a changing environment.

The potential speed of software development, and access to hardware as a relative commodity also promises a decrease in time to market.

However, in practice a move to software-defined systems is not only a case of shift of complexity from hardware to software, but is also frequently an overall **increase in complexity**, as the malleable characteristics of software are taken advantage of. The relative ease by which new systems can be created drives innovation and therefore diversity, contributing to industry fragmentation.

A software-defined approach whilst providing many valuable capabilities to space supply chains, does more to exacerbate than solve the fundamental issues creating fragments and silos.

## NOVEL ARCHITECTURES

As the range of space-based services has grown, the potential value of aggregating multiple services to create more complex mission architectures has become increasingly clear.

Common approaches include **hybrid systems** for both sensing and the delivery of derived insights into the field through a combination of EO and communications, and the use of multiple sensing constellations to form a tip-and-cue system where the coarse-grained analysis of a potential target triggers higher-resolution data gathering.

Given the diversity of the industry, there is **huge potential** in the creation of a wide range of services through various combinations of existing capabilities. These combinations could offer anything from reducing the time to actionable data to the creation of entirely new insights through fusion of data products.

Whilst offering exciting potential, novel mission architectures exacerbate the challenges we outline here, putting additional pressure on finding suitable solutions to be able to make full use of a range of capabilities in combination.

## CLOUD TECHNOLOGY

Although no longer sufficiently novel to be considered Deep Tech, the principles and core technology of Cloud computing are still under-utilised within the space industry.

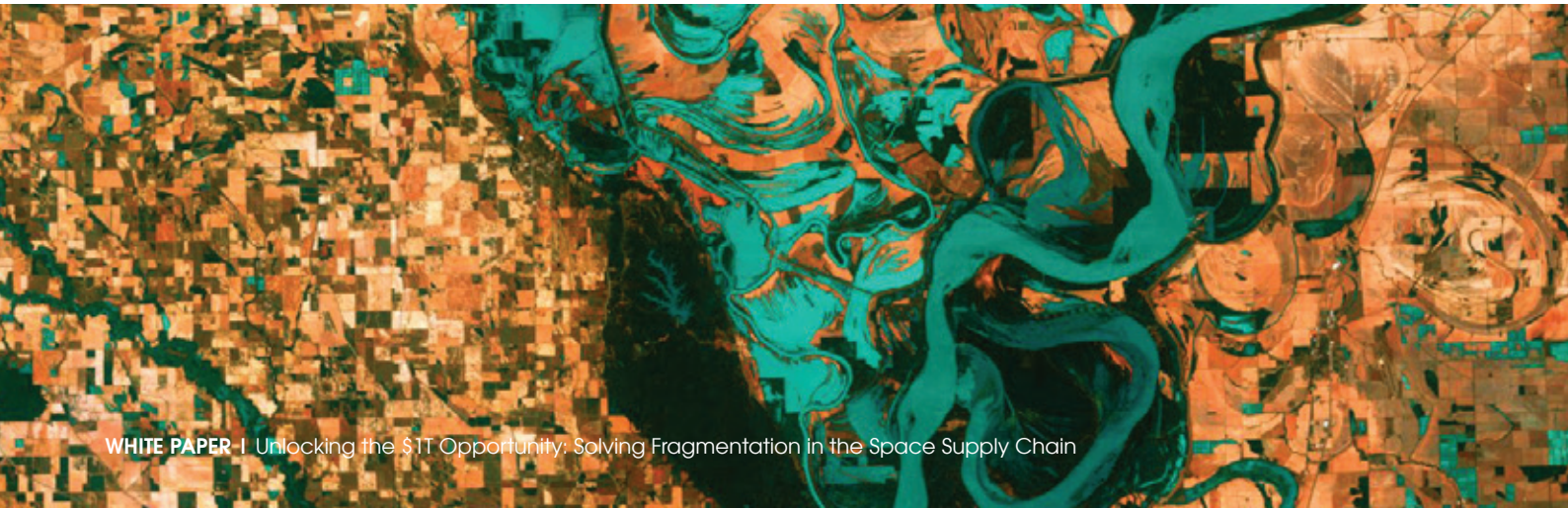
The key characteristics of cloud, such as physical location independence and scaling of metered resources to meet demand, have most relevance within ground systems but are worth considering from an industry-wide perspective.

Cloud-adjacent technologies, such as **edge** and **fog computing** developed within the IoT domain, can provide valuable lessons in working with **large-scale distributed systems** with intermittent communication and a mixture of compute resources. Whilst the combination of edge/fog/cloud technologies contains obvious parallels with flight/ground/downstream space systems, there are key differences within the space industry that limit the ability to directly apply these technologies to space beyond the principles and lessons from other domains.

For example, the compute environment and resources involved in typical space data supply chains are highly diverse, especially in the case of satellite payloads. As highlighted at the start of this white paper, this is a feature and not a bug of the space industry, driving valuable innovation.

Similarly, the shift from ownership to metered access for infrastructure assets makes less sense for the space industry where government is often a cornerstone of the customer mix, security and data sovereignty are a key concern and export controls apply widely to both software and data.

*Whilst exciting, and a valuable contribution to industry capabilities, these innovations primarily focus on **challenges within silos**, rather than the broader industry issues and so do not contribute to helping the industry break through the barriers to demand-led growth which will be important in the coming 3-5 years.*



## SOFTWARE INFRASTRUCTURE IS UNDERVALUED

**Fundamental infrastructure** has been undervalued in the industry. This oversight has been recognised by those taking a bird's eye view of the industry, such as investors, analysts and industry commentators. However, this focus has tended to be on in-orbit infrastructure, such as in-space assembly and manufacturing, or space situational awareness and traffic management, as has been highlighted by prominent industry observers such as Seraphim Space. Whilst vital to the future of the industry, these concerns overlook the wider infrastructural challenges facing the data and service supply chain.

To best meet downstream demand innovation in software infrastructure is overdue. Solutions are needed which can help manage the inherent complexity of systems-of-systems and provide the means to use **COTS software** without limiting diversity and organic demand-driven growth. Experience has shown that the industry will not concentrate on a single technology, and this has been a strength. Therefore, any technology put forward to solve these issues must be capable of being **deployed piecemeal**, starting within the silos it is aiming to address, incrementally offering value.





*HELIX addresses the supply chain fragmentation challenge by providing a modular, open platform that **connects solutions** across the entire supply chain into a single, **coherent ecosystem**.*

*By acting as a harmonisation layer, it allows different technologies to work together seamlessly, reducing silos while preserving flexibility and innovation.*

## BRIGHT ASCENSION'S HELIX TECHNOLOGY

Bright Ascension's HELIX technology has been created specifically to address these challenges right across the industry. HELIX is built on a unique platform technology with a modular, open architecture creating an **information-rich infrastructure**. This platform is built into individual products which address specific needs across the complete supply chain, together creating a **complete and coherent ecosystem**.

As the critical element required to solve the fundamental industry challenges outlined here, the HELIX products act as infrastructure which offers **value in their own right**, but also together act as a **platform** upon which **mission or service-specific capabilities** can be built. The open HELIX infrastructure also acts as a harmonisation layer, permitting a diverse range of **COTS hardware and software** to be applied interchangeably, promoting flexibility and vendor independence. This approach to harmonisation enables powerful aggregation, readily permitting the creation and maintenance of systems-of-systems, without requiring a reduction in diversity.

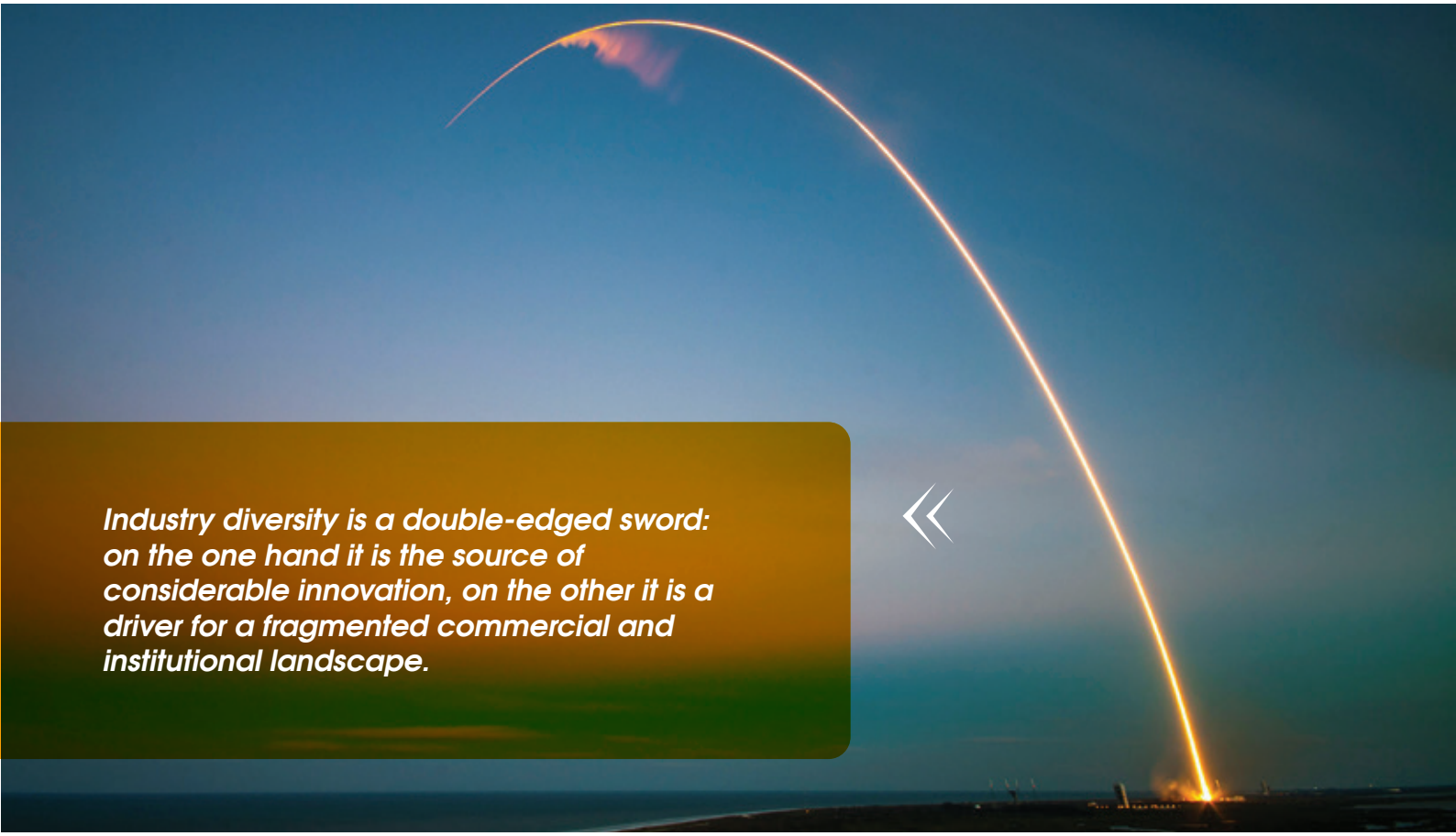
The technological foundations of HELIX enable these powerful properties, with the HELIX products permitting application to the space supply chain either in part or in whole.

*We will be presenting a **deep dive into the core HELIX technology**, and how it is uniquely able to address industry challenges, in a **forthcoming whitepaper**.*

## UNLOCKING DOWNSTREAM DEMAND

The contemporary space industry is exhibiting clear signals that growth, and profitability is not limited by downstream demand, but rather by **structural limitations in upstream supply**. These limitations ultimately derive from fragmentation and siloing which cause challenges around time-to-market, integration, scalability, maintainability, security and overall efficiency. Industry diversity is a double-edged sword: on the one hand it is the source of considerable **innovation**, on the other it is a driver for a **fragmented** commercial and institutional landscape.

Bright Ascension's **HELIX technology** breaks down industry barriers, permits and encourages diversity, enables innovation, and provides an alternative path to the walled gardens of vertical integration. Harnessing the core technology of the HELIX platform will allow the industry to reach its full growth potential in the next decade, **unlocking the $1T market** and driving profitable growth throughout the supply chain.




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# ABOUT BRIGHT ASCENSION

Bright Ascension is a Scotland-based industry-leading space software technology provider, offering unique software products and solutions for the delivery of space-based services, both on spacecraft and on the ground.

Our pioneering HELIX suite of space software products is built on our innovative software technology that has been tried and tested in flight with over 60 satellites in orbit.

**Want to learn more?**

Contact us today to book a consultation with our experts:



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