Delivering Smallsat in a few weeks: Advancing Responsive Space Capabilities with Scalable Platforms

Helena Milevych
Product Management
Argotec srl
San Mauro Torinese, Turin, Italy
helena.milevych@argotecgroup.com

Matilde Tinti
Product Management
Argotec srl
San Mauro Torinese, Turin, Italy
matilde.tinti@argotecgroup.com

Emilio Fazzoletto
Product Management
Argotec srl
San Mauro Torinese, Turin, Italy
emilio.fazzoletto@argotecgroup.com

Ludovica Bozzoli
Product Management
Argotec srl
San Mauro Torinese, Turin, Italy
ludovica.bozzoli@argotecgroup.com

Abstract – **Responsive space marks a fundamental shift in the way space-based services are developed, launched and operated. This evolution toward more adaptive architectures is driven by the growing need for rapid delivery, cost efficiency, and technical competitiveness in both commercial and military domains, at a pace that conflict with legacy satellite development processes, making the traditional approach unsustainable. As a result, a new operational model is necessary to support faster, informed decisions and to strengthen mission resilience. Space is evolving into a domain where responsiveness and adaptability are no longer optional, but structural requirements.**

In response, Argotec evolves into an end-to-end mission provider with the in-house manufacturing and industrialized approach. This strategy aligns with the ESA Strategy 2040 aiming to secure Europe's autonomy, competitiveness, and environmental responsibility in an increasingly commercialized space domain. Flexible, scalable, upgradable platforms, like HAWK Plus, Argotec's new modular microsatellite, become enablers for fast and cost-effective launches, balancing reliability with flexibility.

Further improving the swift response demonstrated in 2025 with HEO (Hawk for Earth Observation is the Earth observation constellation developed by Argotec within the IRIDE programme, a strategic initiative IRIDE Programme — Earth Observation program, funded by PNRR funds and developed by the European Space Agency - ESA in collaboration with the Agenzia Spaziale Italiana, initiated by the Presidenza del Consiglio dei Ministri - European Commission - Italia Domani) and derived satellite programs, Argotec proposes a payload agnostic platform architecture, based on function specific bays, allowing future upgrades without the need for full redesigns, necessary in the current geopolitical and operational dynamics where the demand for resilient, dual use, and space capabilities are crucial to evolving scenarios.

This approach also led to HAWK Grid, a partnership program bringing together suppliers and users with pre-integrated, flight-ready solutions, supporting the idea of Europe's sovereignty and strategic cooperation with a focus on the cost and lead time reduction.

With HAWK Plus, Argotec can bring the production up to 1 satellite per week manufacturing the entire product in-house, from concept and design to implementation and in-orbit operations. This paper explores Argotec's approach in redefining how capabilities are delivered to ensure a more responsive space.

*Keywords – **responsive space, modular platform, industrialization, HAWK Plus, European sovereignty, mini satellite, smallsat.***

I. INTRODUCTION

A. *Scope and objective of this paper*

This paper addresses how industrialized, modular smallsat platforms can enable responsive space capabilities on timelines measured in weeks rather than years. The discussion is anchored in Argotec's evolution toward an end-to-end mission delivery model spanning in-house manufacturing, integration, qualification, launch readiness support, in-orbit operations and in the development of scalable platforms designed for rapid configuration and upgrade.

In particular, the paper showcases HAWK Plus, Argotec's modular microsatellite platform having a payload-agnostic architecture enabled by function-specific bays. This approach supports rapid payload integration, easier upgrade paths, and repeatable AIT processes, with the objective of maintaining reliability while reducing lead time and cost. The paper also describes how this platform philosophy extends to ecosystem-level responsiveness via HAWK Grid, a partnership model intended to integrate suppliers and users around pre-qualified, flight-ready building blocks to reduce integration burden and accelerate deployment.

Finally, the paper references demonstrated responsiveness through recent and ongoing IRIDE mission program with the rapid development associated with Argotec's HEO constellation (Hawk for Earth Observation is the Earth observation constellation developed by Argotec within the IRIDE programme, a strategic initiative IRIDE Programme — Earth Observation program, funded by PNRR funds and developed by the European Space Agency - ESA in collaboration with the Agenzia Spaziale Italiana, initiated by the Presidenza del Consiglio dei Ministri - European Commission - Italia Domani).

B. *Evolution of responsive space*

Responsive space has progressively emerged as a structural requirement for space-based services, reshaping the way space systems are conceived, delivered, and operated. Originally associated with the rapid launch of smallsats to restore or augment capabilities, responsiveness today encompasses the entire mission lifecycle: requirements definition, platform configuration, payload integration, qualification, launch readiness, and on-orbit operations. This evolution is driven by the increasing pace at which users, like commercial, institutional, and defence, need space assets to be designed, deployed, and adapted. However, while access to space has accelerated, different development and procurement processes have not. This mismatch creates a growing gap between what stakeholders increasingly demand (e.g. agility, adaptability, and rapid deployment) and what satellite manufacturers and integrators can realistically deliver.

Therefore, in this broader sense, responsive space implies not only speed, but also decision agility and architectural adaptability, which translates as the ability to configure missions quickly, integrate new payloads with limited rework, and update capability as operational needs evolve. In this context, responsiveness is no longer an optional optimization; it becomes a foundation for resilience, competitiveness, and strategic autonomy.

C. *Limitations of traditional satellite development*

Traditional satellite programs are becoming increasingly unsustainable in scenarios where requirements evolve quickly, technology cycles shorten, and unforeseen events reshape priorities.

Conventional satellite development processes are affected by a set of structural constraints that limit responsiveness. Heavy reliance on early, fixed requirements typically results in late design freezes, restricting the ability to respond to evolving mission needs without extensive redesign. At the same time, extensive customization at platform and subsystem level drives non-recurring engineering effort, extending lead times and constraining scalability. These effects are amplified by serial AIT processes, in which assembly, integration, and qualification are executed sequentially, creating critical schedule bottlenecks. Supply chain latency further exacerbates these constraints when procurement strategies and vendor lead times are not aligned with industrialized production. Moreover, treating mission operations as a downstream concern reduces the effectiveness of rapid commissioning and post-launch adaptability.

These factors collectively lead to a mission timeline that conflicts with today's tempo of commercial competition and geopolitical dynamics. The result is a growing need for a new operational and industrial paradigm: one where a mission can move from intent to orbit with reduced cycle time, while retaining reliability, mission assurance, and cost efficiency.

D. *Market and geopolitical drivers for rapid deployment*

The drivers behind responsive space are both market-based and geopolitical.

On the commercial side, the smallsat ecosystem has shifted toward faster iteration cycles and a higher tolerance for incremental upgrades. In Earth observation and communications markets, customer value is increasingly tied to the timeliness of data delivery, constellation refresh rates, and the ability to deploy capability where and when demand peaks. Commercial operators are thus incentivized to shorten development timelines and adopt modular architectures that can be scaled and upgraded without repeated full redesigns.

On the institutional and security side, the value of rapid space capability delivery has become more evident. Modern operational scenarios can require swift augmentation, reconstitution, or diversification of space assets to mitigate disruptions and maintain service continuity. Resilience objectives increasingly favour distributed architectures and flexible constellations rather than single high-value nodes. This reinforces the need for platforms that can be configured quickly, produced at scale, and launched with minimal delay.

Moreover, Europe's ambition to strengthen autonomy and competitiveness in an increasingly commercialized domain adding urgency. In such a context, responsiveness is linked not only to operational outcomes, but also to industrial capacity, supply chain sovereignty, and the ability to sustain strategic cooperation across the European space ecosystem.

II. THE NEED FOR RESPONSIVENESS IN MODERN SPACE MISSIONS

A. *Commercial trends: time-to-orbit as a competitive advantage*

Commercial space markets increasingly reward speed of delivery and service agility alongside pure spacecraft performance. The value of a mission is tightly linked to the ability to place new sensing or communication capability on orbit quickly, whether to exploit time-limited market opportunities, respond to emerging customer demand, or outpace competitors through faster iteration cycles.

This shift is reflected in the rapid growth of the small satellite market. According to "Smallsats by the Numbers 2024" published by BryceTech [1], a total of 2,860 small satellites (defined as having a mass of ≤1,200 kg) were launched in 2023 alone, with the number of commercial smallsats increasing from 115 in 2014 to 2,629 in 2023. Over the period 2014–2023, more than 8,500 commercial smallsats were launched, highlighting a sustained acceleration in deployment rates and a clear transition toward constellation-based business models [1].

This acceleration is also evident in recent launch statistics: according to "Q4 2025 Global Space Activity" by BryceTech [2], 1,404 spacecraft were launched in the fourth quarter of 2025 alone, with small satellites (≤1,200 kg) accounting for 98% of launched spacecraft and approximately 83% of total up mass, confirming the central role of smallsats in today's commercial launch activity.

While much of this growth is driven by large broadband constellations, BryceTech data show that deployments of non-broadband constellation spacecraft have also increased, indicating expanding demand across Earth observation, data services, and specialized commercial applications [1]. Notably, 2023 marked the first year since 2018 in which first-time satellite operators deploying smallsats outnumbered operators with previous deployments, signalling continued market entry and diversification rather than saturation [1].

These dynamics have reshaped traditional program trade-offs. Whereas legacy satellite programs prioritized maximum performance and long operational lifetimes, many smallsat business models now emphasize shorter development cycles, scalable manufacturing, and repeatable platform architectures. Faster deployment reduces time-to-revenue and mitigates the cost-of-delay, while also lowering exposure to requirement changes. At the same time, compressed development cycles enable more frequent technology refresh, allowing operators to incorporate advances in sensors, onboard processing, and communications without waiting for multi-year qualification processes.

In parallel, launch access has become more flexible through rideshare opportunities and an expanding ecosystem of launch providers. However, access to launch alone does not guarantee responsiveness. As large commercial telecommunications constellations continue initial deployments and move toward constellation expansion phases, launch availability will increasingly interact with platform readiness and production cadence [1]. As a result, compressed schedule must be achieved through platform availability, integration simplicity, streamlined AIT, and quick commissioning. Consequently, the commercial definition of responsiveness extends beyond "rapid launch" to "rapid delivery of capability," emphasizing end-to-end throughput from mission definition to operational service.

B. *Defence and dual-use requirements: resilience, agility, survivability*

In defence and dual-use context, responsiveness is increasingly framed as an enabler of resilience and operational superiority, with space capabilities that are now expected to remain available under uncertain and contested conditions.

In this setting, three capability drivers stand out:

- Resilience through distribution: Distributed architectures and proliferated constellations can reduce single points of failure and improve mission continuity by spreading capability across multiple assets. Responsiveness supports this paradigm by enabling rapid deployment of additional nodes and faster replenishment of degraded capacity. This is particularly relevant in scenarios, such as jamming interferences, where the ability to reconfigure services across distributed assets and restore functionality quickly becomes a key contributor to overall system resilience.
- Agility to changing mission priorities: Dual-use missions must sometimes shift focus quickly (e.g., from routine monitoring to crisis response). Responsiveness therefore requires not only rapid production and launch, but also adaptable platforms capable of hosting different payload types and integrating new functions without restarting a full development cycle. Advanced on-board data processing and AI-enabled functions further support this agility by allowing data to be processed, filtered, and prioritized directly in orbit, enabling faster reaction to evolving operational needs.
- Survivability and reconstitution: In scenarios where assets are threatened or denied, the ability to reconstitute capability on short timelines becomes strategic.

Within this frame, responsiveness is less about incremental schedule savings and more about strategic assurance: the capacity to provide services reliably across changing, scaling, and unpredictable operational conditions. The implication is that speed should be achieved without sacrificing mission assurance, which places strong emphasis on flight-proven building blocks, repeatable qualification, and controlled configuration management.

C. *Regulatory and institutional push*

Institutional roadmaps in Europe increasingly emphasize autonomy, competitiveness, and sustainability in a space domain characterized by commercialization. This trend translates into a stronger focus on industrial capacity, European supply chain robustness, and the ability to deploy assets with reduced dependence on non-European critical elements.

A critical driver is the "normalization" of rapid integration practices, made possible by progress in smallsat avionics maturity, modular subsystem design, and increasingly standardized verification approaches. Over time, what was considered "fast" has become a baseline expectation. This shift has been enabled by several reinforcing trends, like:

- Flight-proven avionics and software frameworks: Reusing validated building blocks reduces verification burden and improves confidence when schedule is compressed.
- Modular mechanical and electrical interfaces: Standardized interfaces allow payloads and subsystems to integrate with less custom engineering and fewer late-stage traps.
- Digitization and model-based engineering practices: Better traceability and configuration control support parallel workstreams and reduce iteration overhead.
- Industrialized AIT: Repeatable test setups, predefined procedures, and parallelizable flows reduce cycle time while maintaining rigor.

The core idea is that responsiveness is not achieved by working "faster" in the final months of a program; it is achieved by designing the organization, the platform, and the supply chain to make speed a repeatable outcome.

This approach is reflected at programmatic level through recent European initiatives that explicitly frame industrialization, scalability, and responsiveness as strategic enablers. ESA M-IND (Mid-size satellites INDustrialisation) initiative highlights the need to move from project-centric development toward sustained production capacity for LEO constellations. M-IND addresses this transition through three closely related objectives – competitiveness, industrialization, and European sovereignty – in alignment with the ESA Strategy 2040, recognizing that responsiveness relies on industrial readiness and supply-chain control.

In this context, M-IND's primary objective is to scale up satellite production volumes, thereby reducing both cost and lead time for the development and deployment of high-impact missions. Rather than focusing on single bespoke systems, the initiative promotes repeatable and adaptable platform elements, standardized interfaces, and payload-agnostic architectures that can be produced at scale and configured across multiple applications. This approach supports a pragmatic path toward higher manufacturing cadence, interoperability, and multi-sourcing, while enabling both institutional and commercial missions to benefit from faster delivery timelines and improved cost efficiency [5].

In parallel, initiatives such as European Resilience from Space (ERS) further reinforce the role of rapid integration as a prerequisite for future space capabilities, particularly in dual-use and security-driven contexts [6]. By promoting integrated architectures that combine Earth observation, secure communications, navigation, and on-board data processing, ERS underscores the importance of platforms that can be configured, deployed, and evolved quickly to support responsive and resilient services.

D. *Implications: responsiveness as an end-to-end system property*

Taken together, these drivers converge toward a common conclusion: responsiveness should be treated as an end-to-end system property. It is not limited to launch responsiveness; it requires readiness across the full lifecycle, starting from the design of a configurable and upgradable platform baseline with controlled variants and a payload accommodation that minimizes integration efforts, and continuing to the AIT, operational and industrial flow.

Argotec's transition to an industrialized end-to-end model and the development of modular platforms such as HAWK Plus are intended to translate these requirements into a practical capability: delivering smallsat missions on compressed timelines while preserving reliability and mission assurance.

III. HAWK PLUS: ENABLING SCALABLE, MODULAR AND UPGRADABLE SMALLSAT PLATFORMS

A. *Platform architecture overview*

HAWK Plus, Argotec's modular microsatellite platform, integrates responsiveness as an intrinsic platform property. Its design aims to deliver a platform that can integrate diverse payload classes and accommodate upgrades while preserving mission assurance through the reuse of flight-proven elements. Thus, the HAWK Plus platform is a repeatable product with configuration variants, enabling a rapid transition from mission intent to flight-ready spacecraft [4].

At system level, the platform consists of three main Decks, visible in Figure 1:

- **Payload Deck**, dedicated to accommodating one or more payloads,
- **Avionic Deck**, hosting the spacecraft avionics subsystems, and
- **Propulsion Deck**, which integrates the propulsion system and externally interfaces with the launch vehicle.

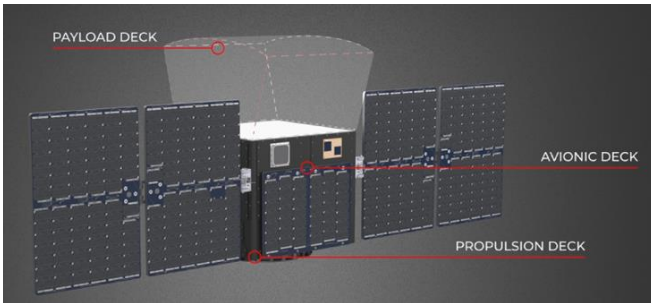

Fig. 1. HAWK Plus structure

The Avionic Deck has a critical importance, and it is divided into dedicated bays, which are designed as structural compartments that host subsystems according to their functional domain, thereby supporting modular integration and controlled configuration changes [3].

Two available platform's configurations, Baseline and Extended, guide early trade-offs while preserving a common structural layout. The Baseline configuration of HAWK Plus leverages the HEO constellation expertise supporting scalable performance, while the Extended configuration increases available power and propulsion capacity through additional power conditioning, distribution units, and extra battery packs, as visible in Table 1.

TABLE I. HAWK PLUS PERFORMANCE (BASELINE AND EXTENDED CONFIGURATIONS)

Parameter	***Baseline Configuration***	***Extended Configuration***
Payload Allocated Mass	30 kg	
Payload Allocated Volume	L 540 x W 540 x H 300 mm (on Payload Deck) with additional L 340 x W 340 x H 302 mm (Central Core of Avionic Deck)	
Payload Electrical Interface & Peak Power	5V line: 20 W 12V line: 48 W 28V line: 240 W	5V line: 40 W 12V line: 144 W 28V line: 400 W
Payload OAP, Sun Point	20 W	100 W
Total S/C Wet Mass at Launch	122 kg (including Payload and margins)	147 kg (including Payload and margins)
Bus Dry Mass	85 kg (w/o Payload)	98 kg (w/o Payload)
Solar Array Power Generation BOL (AMO)	200 W	Up to 350 W
Battery Capacity	270 Wh (Operative Range)	Up to 340 Wh (Operative Range)
Comms Data Band	S-Band, X-Band	S-Band, X-Band, L-Band
DV Capabilities	Electrical Baseline 1 – 140 m/s Electrical Baseline 2 – 290 m/s Chemical Alternative: 60 m/s - 110 m/s-230 m/s	
Designed Lifetime	5 Years in LEO (depending on mission scenario and Payload)	

From a responsiveness standpoint, the platform architecture is guided by three core principles: modularity, to decouple mission-specific elements from the recurring spacecraft core; standardized interfaces, to enable the reuse of integration and verification activities across missions; and industrialization, to sustain manufacturing through repeatable AIT flows and controlled supply and production processes. Together, these principles underpin the ability to compress development and delivery timelines without relying on schedule-risky customization.

B. *Modular function-specific bays and payload-agnostic design*

A key architectural enabler in HAWK Plus is the adoption of function-specific bays. This bay-based approach supports payload-agnostic accommodation, enabling different payload types to be integrated with little to no change. In responsive missions, requirements may evolve late or new payload opportunities may arise on short notice. The bay architecture provides a structured mechanism to absorb such changes while maintaining a controlled configuration and predictable integration boundaries.

Following this approach, the Avionic Deck is organized into a set of dedicated bays, visible in Figure 2. The Avionic Deck has two Electrical Power System (EPS) bays, one Attitude and Orbit Control System (AOCS) bay, and one Avionic Bay. The two EPS bays are located adjacent to where the solar panels are mounted, and host the complete EPS suite, including power conditioning and distribution units (ZEUS), batteries (ELEKTRA), and associated hardware and harnessing. The AOCS bay accommodates the core attitude control electronics together with the GNSS suite and star trackers. The Avionic Bay is dedicated to platform avionics, including the on-board computer and telecommunication hardware.

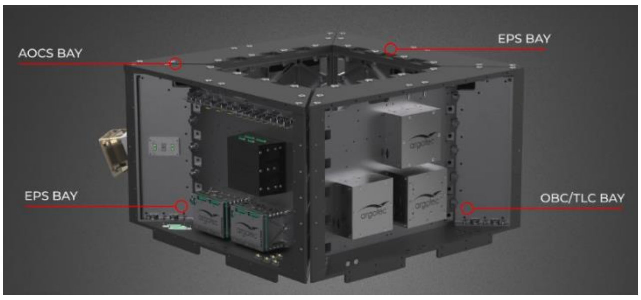

Fig. 2. HAWK Plus Avionic Deck

The Avionic Deck also includes a central volume, referred to as the Central Core, which provides additional accommodation margin for mission-specific elements. This volume can be allocated to host supplementary payload electronics, additional fuel capacity through extended tanks, or deployable subsystems such as antennas, depending on the mission scenario. Together, the bay-based organization and the availability of the Central Core support modular configuration without propagating redesign.

C. Manufacturing approach supporting upgrades without redesign

HAWK Plus responsiveness is not only architectural; it is also industrial. Modular bays enable localized upgrades and therefore the manufacturing approach is based on the following objectives:

- **Maintain a stable production baseline**: preserving repeatability and allowing procurement and manufacturing planning to operate with predictable cadence.
- **Enable controlled insertion of upgrades:** integrating evolutions (e.g., a revised EPS block, a new communication option, a payload interface adapter) through configuration-controlled variants rather than ad-hoc engineering.
- **Reduce re-qualification scope:** by limiting change impact to a bay and leveraging reuse of flight-proven avionics and processes, verification efforts can focus on deltas rather than re-testing the full spacecraft stack.

This approach supports continuous platform evolution necessary in a context where technology and mission requirements change quickly while protecting the reliability advantages gained through reuse and industrial discipline.

D. Streamlined AIT (Assembly, Integration, Testing) processes

HAWK Plus design aims to reduce AIT bottlenecks by coupling modular architecture with repeatable, streamlined AIT flows. In practice, such approach is enabled by:

- **Bay-level test points and acceptance logic:** facilitating faster verification at module level and reducing late-stage troubleshooting complexity.
- **Integration workstreams in parallel:** allowing multiple bays and spacecraft segments to be assembled and verified simultaneously before final spacecraft integration.
- **Re-use of procedures and test configurations:** improving schedule predictability and reducing learning-curve effects between missions.

The combined effect is a reduction in the iterative cycles typically caused by late interface issues, non-standard wiring, and bespoke test setups, that are common barriers to responsiveness in traditional satellite developments.

E. Production scalability: toward one satellite per week

Responsive space requires not just one fast mission, but repeatable capacity at a certain pace. The HAWK Plus platform aims to sustain production scalability up to one satellite per week under an industrialized model where key activities, from manufacturing to integration and preparation for operations, are executed in-house with expected cadence.

In some missions, time-to-orbit itself is a strategic capability as it supports rapid deployment, replenishment, and adaptation across commercial, civil, and dual-use contexts. HAWK Plus is a scalable platform that turns responsiveness from a mission-by-mission aspiration into a sustained delivery model.

F. In-house Mission Control Center as the backbone for full-service operations

Argotec operates missions in-house through the Mission Control Centre (MCC), treating operations as a critical element of missions' management and a part of the delivery chain.

Fig. 3. Argotec's Mission Control Centre

The MCC, shown in Figure 3, serves as the central hub for flight operations across all company missions. The facility is qualified to operate with major ground segment infrastructures, including NASA's Deep Space Network, the European Space Agency's ESTRACK, and commercial ground station networks. Historic missions such as LICIACube and ArgoMoon have been successfully operated from this centre, demonstrating both operational maturity and deep space heritage. The MCC provides real time spacecraft monitoring and control, and integrates dedicated software tools for mission planning, anomaly detection and resolution, as well as operational data analysis.

This approach supports responsiveness in:

- **Operational readiness from early phases:** procedures, command databases, and mission plans can be developed alongside the spacecraft and payload definition, reducing post-launch delays.
- **Faster commissioning and calibration loops**: integration between engineering and operations teams enables rapid anomaly resolution and quicker convergence to nominal service.
- **Closed-loop feedback for platform improvement**: operational data provides evidence for incremental design improvements, supporting continuous refinement of the platform baseline and AIT processes.
- **Single accountability and simplified interfaces for customers:** end-to-end service reduces coordination overhead and improves decision speed, particularly in time-critical deployments.

Crucially, the MCC is not simply a support function; it becomes an active enabler of time-to-service. Responsive missions also require activation and validation of missions' functions quickly after separation, with reliable monitoring and the ability to adapt operations to evolving mission needs.

IV. CASE STUDIES AND DEMONSTRATED PERFORMANCE

A. HEO for IRIDE: Demonstrating rapid development

HEO (Hawk for Earth Observation) is the Earth observation constellation developed by Argotec within the IRIDE programme, a strategic initiative promoted by the Italian Government, funded through the National Recovery and Resilience Plan (PNRR), and coordinated by the European Space Agency and Italian Space Agency. IRIDE aims to provide Italy with a sovereign, constellation-based Earth observation capability to support environmental monitoring, institutional services, and security-related applications, representing one of the most ambitious Earth observation programmes currently underway in Europe [7][8].

Within this framework, Argotec contributes with the HEO constellation, designed as a new generation evolution of the HAWK platform and conceived to scale up to several tens of satellites. The constellation architecture supports a scalable deployment of up to 40 spacecraft in LEO, distributed across altitudes between approximately 500 and 600 km. This configuration enables frequent revisit times – down to a minimum of a few hours – while preserving flexibility for incremental constellation build-up and capability growth.

From a responsiveness perspective, HEO, visible in Figure 4, provides a concrete demonstration of rapid development and deployment within an institutional programme. The first HEO satellite was designed, manufactured, launched, and successfully operated **within approximately 18 months**, a timeline that would have been difficult to achieve using traditional satellite development approaches. This acceleration was enabled by Argotec's fully integrated operational model, concentrated at its SpacePark headquarters in Turin, Italy, where system engineering, manufacturing, assembly, integration, testing, and mission operations work closely together. Organizational structure allowed extensive parallelization of activities, swift decision-making, and tight control of the mission critical path without compromising mission assurance.

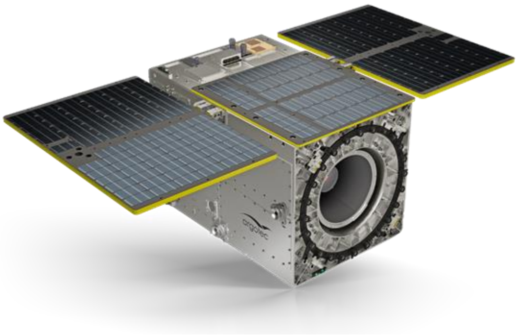

Fig. 4. HEO for IRIDE

The HEO satellites build upon the heritage of the already flown deep-space missions – LICIACube and ArgoMoon – which demonstrated Argotec's capability to operate microsatellites well beyond LEO. Leveraging this heritage, HEO brings enhanced performance in terms of reliability, computing capability, and versatility. Each satellite, with a mass of approximately 70 kg, is equipped with a multispectral optical payload operating in the visible and near-infrared bands, enabling applications ranging from vegetation and soil monitoring to the detection of deforestation, erosion, fires, floods, and changes in urban infrastructure [3].

A distinguishing element of the HEO satellites is its advanced on-board data processing capability. AI-enabled computing resources allow part of the image processing chain to be executed directly on board, reducing data volumes to be downlinked and supporting faster delivery of actionable information to the end users. In this sense, HEO satellites act not only as sensors, but also as autonomous processing nodes capable of acquiring, analysing, and prioritizing data in orbit – an important enabler for time-sensitive services.

Fig. 5. Argotecs' Clean Room with HEO satellites

Beyond the technical and programmatic achievements, IRIDE has also acted as a catalyst for industrial scaling. The programme supported the development of Argotec's SpacePark, an integrated facility hosting serial production lines, test infrastructure, and mission operations under a single organizational framework. This industrial investment underpins the ability to transition from single-satellite delivery to sustained constellation deployment and represents a key enabler for responsive space capabilities at scale.

Overall, the HEO/IRIDE experience demonstrates that rapid development, scalable production, and advanced on-orbit functionality can be achieved within an institutional programme when platform architecture, industrial capacity, and operations are addressed as a coherent end-to-end system. The lessons learned from HEO directly inform the evolution toward platforms such as HAWK Plus, where responsiveness is embedded at platform level to support higher production cadence, upgradeability, and broader mission diversity.

B. *The HAWK GRID ecosystem*

As discussed throughout this paper, achieving true responsiveness requires extending industrialization and modularity beyond the spacecraft platform itself; in this context, HAWK Grid was introduced to address integration and mission readiness at ecosystem level.

Built around the industrial HAWK Plus platform, HAWK Grid establishes an open and collaborative ecosystem that aligns platform provider, subsystem suppliers, payload developers, and end users around a shared framework for mission readiness. HAWK Grid promotes a shift from a one-time mission development toward industrialized mission design, leveraging a robust, modular platform and standardized interfaces as a common integration backbone.

Within this ecosystem, subsystem and payload providers are treated as strategic partners. Through a structured compatibility and qualification process, partner solutions are validated against the HAWK Plus architecture and operational constraints. Once qualified, these solutions become visible, reusable, and integration-ready building blocks that can be selected as standard options. This approach creates a catalogue of pre-qualified elements from which mission designers can configure spacecraft solutions, reducing uncertainty in integration effort, verification scope, and schedule impact.

The pre-integration philosophy underpinning HAWK Grid directly addresses key drivers of cost and lead-time growth in smallsat missions. It also reduces the duration and variability of AIT activities and supports greater parallelization between manufacturing, integration, and verification. For constellations, this effect is amplified: once a configuration is validated, it can be replicated across multiple units with controlled variation, supporting higher production cadence and reduced cost per satellite. Standardized integration paths, controlled configuration management, and repeatable qualification logic enhance reliability while preserving flexibility for mission-specific tailoring at payload and bay level.

Together, HAWK Plus and HAWK Grid extend responsiveness from platform design to ecosystem alignment. By transforming integration into a structured, reusable capability shared across the value chain, HAWK Grid enables scalable, multi-mission deployment while maintaining mission assurance, contributing to making rapid and reliable space mission delivery a repeatable outcome rather than an exception.

V. CONCLUSIONS

In general, responsive space is moving from concept to operational expectation. Europe's strategic positioning therefore depends on the ability to adopt responsiveness as a sustained capability supported by the industrial capacity and repeatable operational readiness. Within this landscape, Argotec's approach, as an end-to-end delivery combined with modular platforms, aligns with the global best practices.

This paper focuses on responsive space as an overall requirement driven by commercial acceleration, institutional priorities, and the need for resilience and adaptability. In this context, the experience gained through the HEO constellation within the IRIDE programme provides concrete evidence that rapid development and deployment are achievable within an institutional framework through the coherency of platform reuse, industrialization, and mission operations.

As distributed architectures and proliferated constellations become more common, the delivery model becomes essential for resilience. At platform level, HAWK Plus illustrates how a payload-agnostic, bay-based architecture supports rapid mission configuration, scalable performance, and upgrade paths while preserving a stable system baseline.

Beyond the spacecraft itself, the introduction of HAWK Grid extends these principles to the ecosystem level. By enabling pre-qualified solutions, reducing non-recurring engineering, and aligning suppliers around flight-ready configurations, HAWK Grid contributes to shortening lead times supporting predictability and mission assurance across multi-satellite deployments.

Argotec's approach, as outlined in this paper, aims at contributing to a European responsive space ecosystem by combining modular platform design with industrial capacity and mission operations. Together with ecosystem-level alignment enabled by HAWK Grid, these capabilities provide a foundation for European responsiveness aligned with autonomy, competitiveness, and long-term mission resilience objectives.

REFERENCES

[1] "Smallsats by the Numbers 2024" BryceTech

[2] "*Q4 2025 Global Space Activity*" BryceTech

[3] G. Saita, L. Pattanaro, M. Giolo, R. Torre, L. Conterio, G. Pasini, E. La Bella, and E. Fazzoletto, "Standardization and modularity in satellite design: The Argotec HAWK Plus spacecraft," in Proc. 11th European Conference for AeroSpace Sciences (EUCASS), Rome, Italy, June 30–July 4, 2025

[4] M. Giolo, G. Saita, E. La Bella, G. Pasini, C. Pedrazzini, C. Cerini, M. Di Matteo, and E. Fazzoletto, "HAWK PLUS: A standardized and scalable platform for industrialized small satellite production," in Proc. 76th International Astronautical Congress (IAC), Sydney, Australia, Sept. 29–Oct. 3, 2025

[5] J. Rosello, "Overview of European technology for EO missions and mid-size sat industrialisation initiative (M-IND)," ESA Living Planet Symposium, June 27, 2025. [Online]. Available: https://lps25.esa.int/lps25-presentations/presentations/3251/_3251.pdf

[6] J. Aschbacher, "ESA Director General address, Brussels 28 October," speech delivered at the conference "Space for European Resilience: Rising to the Collective Challenge," Brussels, Belgium, Oct. 28, 2025. [Online].Available:https://www.esa.int/About_Us/Corporate_news/ESA_Director_General_address_Brussels_28_October

[7] ESA, ASI, "IRIDE digital brochure." [Online]. Available: https://indd.adobe.com/view/189e6abd-0804-4430-b6a5-79a89f56f347

[8] Italian Space Agency (ASI), "IRIDE," [Online]. Available: https://www.asi.it/scienze-della-terra/iride