Ateleris Space Portrait - Software and Technology Development

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About Us

Software, algorithms, and digital technologies enable new products and services and drive digital transformation in space, too. Our team develops bespoke, purpose-driven digital solutions with our clients – straightforward, reliable, and fair. Ateleris GmbH was founded in 2016 as a spin-off of the University of Applied Sciences and Arts Northwestern Switzerland (FHNW) and remains closely connected to applied research and development. The four founders privately own the company and employ a team of 15 software engineers with diverse technological backgrounds at its headquarters in Brugg, Switzerland.

We are a technology service provider primarily active in the project business. We have many years of experience in the comprehensive support and realization of software and engineering projects for businesses, industry, and public institutions, both domestically and internationally. Our expertise includes significant experience in space projects, adhering to the European Cooperation for Space Standardization (ECSS) and the Consultative Committee for Space Data Systems (CCSDS) standards. This enables us to build software within the ESA and other space regulatory frameworks, ensuring that our solutions meet the stringent requirements and high-quality standards necessary for space missions.

We support our clients throughout the entire technology lifecycle, from needs assessment and feasibility analysis to implementation and operation.

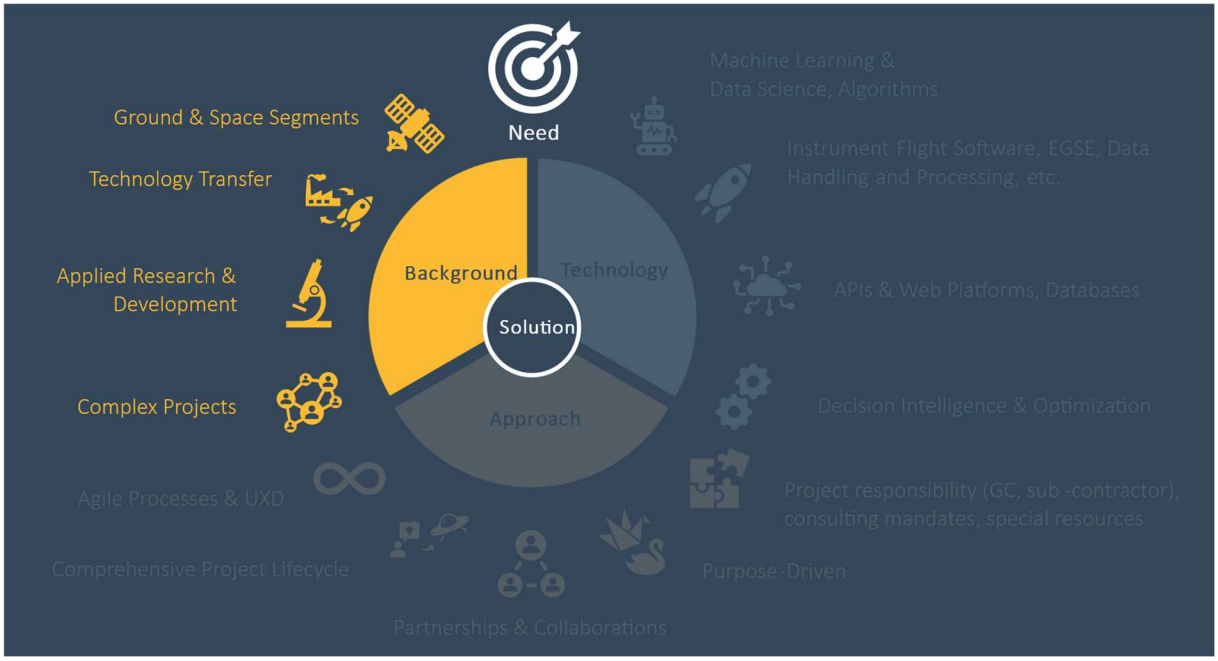

Figure 1: Our background in developing solutions for the ground and space segments.

Our specialty is transferring technology, methods, and know-how from computer science to other fields. This allows us to create solutions for various customer needs: We develop software for space and space research applications, intelligent IoT data applications for industrial clients, and data science solutions for businesses. Furthermore, we support our clients with consulting mandates and embedded development teams.

COMPREHENSIVE SOFTWARE ENGINEERING

Ateleris specializes in comprehensive project-based engineering services, offering a full range of solutions from a single source. Our offerings include engineering, consulting, training, and educational services tailored to meet the specific needs of our clients throughout the entire project lifecycle – from needs assessment and feasibility analysis to implementation and operation.

Space Projects and Standards Compliance

As a prime or subcontractor in software engineering projects for space applications, we adhere to the European Cooperation for Space Standardization (ECSS) and the Consultative Committee for Space Data Systems (CCSDS) standards to build software within the ESA and other space regulatory frameworks. This ensures that our solutions meet the stringent requirements and high-quality standards necessary for space missions.

Our team is well-versed in the ESA project lifecycle for software, as outlined by the ECSS standards. We are proficient in complying with ECSS-E-ST-40C (Software Engineering), ECSS-Q-ST-80C (Software Product Assurance), and ECSS-M-ST-40C (Configuration and Information Management), among others. This deep understanding and adherence to the ECSS framework guarantees that our software solutions are robust, reliable, and aligned with the rigorous demands of space missions.

Figure 2: Software and technology lifecycle with a focus on space projects.

Our Approach

Needs & Opportunities: In the initial phase, we collaborate closely with our clients to identify specific needs and opportunities. Through thorough needs assessments and trade-off analyses, we ensure project goals are clearly defined and realistic.

Requirements & Design: We create detailed requirement profiles and design concepts based on the identified needs. Our engineers and designers work with clients to develop customized, functional solutions. We utilize UXD tools to build mockups, create a shared vision, and ensure we build what the clients truly want. By visualizing processes and making them explicit, we help clients understand and refine their requirements, leading to more effective and efficient solutions.

Implementation, Integration, & Testing: We implement the planned solutions during the realization phase, seamlessly integrating them into existing systems and processes. Our experts ensure precise and efficient execution, employing agile methods to remain flexible to changes. We conduct verification, validation, and testing (VVT) cycles to create robust code using advanced procedures and software reliability tools. Utilizing continuous integration and continuous deployment (CI/CD) pipelines and virtualization and simulation techniques, we support constant regression testing to ensure ongoing quality and reliability.

Maintenance & Operations: Following successful deployment, we offer ongoing maintenance and operational support to ensure the long-term performance and reliability of the solutions, enabling continuous improvements.

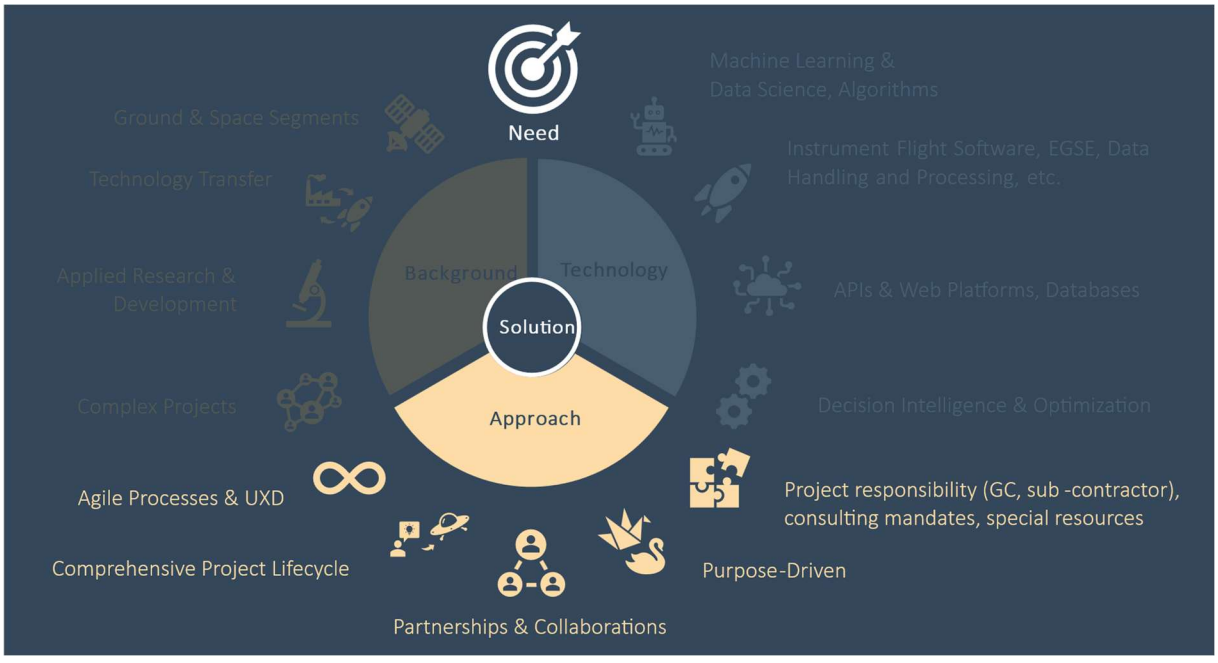

Figure 3: Our approach of focusing on agile methods across the entire project lifecycle with a purpose-driven mindset.

Our Expertise

Our engineering team has a wide range of software and technology development competencies, particularly in the space and research domains. We develop solutions for the ground and space segments, combining technologies and methods from machine learning, data science, algorithmics, API and data platforms, decision intelligence, and optimization.

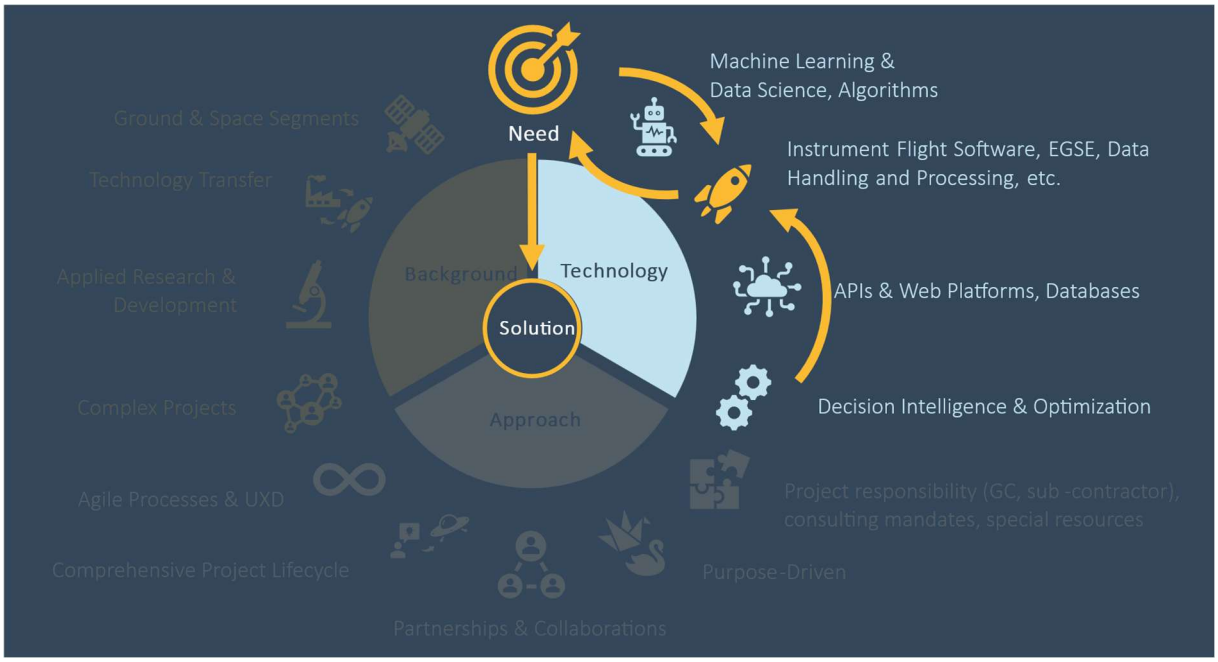

Figure 4: Combining technology cross-sectionally to build bespoke and purpose-driven solutions.

Experience and Adaptability

All our employees have backgrounds in applied research and development. They adapt to the customer's needs, work in challenging and international environments, and use technologies and methodologies in new domains. We have extensive experience building software for both ground and space segments, and we can integrate with and deliver solutions for regulated environments and processes.

DEVELOPMENT APPROACH

We generally select an agile approach over the entire software project lifecycle, with a close collaboration between Ateleris and the client's engineering team. There are a few advantages to using an agile development process:

a) It allows for more flexibility in organically incorporating light changes to the requirements or design during development without implementing and maintaining a complex change management process.

b) It allows for adjusting implementation priorities, e.g., to adapt to schedule changes or readiness of other software or hardware components.
c) By defining shorter implementation cycles (sprints) with intermediate smaller software or code deliveries and regular validation opportunities, the project progress can be better tracked, and potential deviations can be detected earlier.

We extend the agile approach to the initial co-engineering, requirements, and design phase, not just the implementation phase.

We employ issue-tracking tools like GitHub or GitLab to enhance traceability and control. These tools document new and completed tasks, including bug reports, change requests, and discussions. When integrated with source code versioning systems like Git, these tools link code changes to their corresponding issues, ensuring document and configuration control.

Developers are encouraged to enhance code quality by implementing pull requests and requiring code reviews before merging changes into the main branch. A continuous integration and delivery pipeline, such as GitHub Actions, provides a platform for constantly building, integrating, and testing the code. Additional tools, like static code checkers or code coverage utilities, improve the code quality.

If the target software runs on an embedded system or external hardware, a proposed measure for additional code verification is the development of a Digital Twin. A Digital Twin can be integrated into the CI/CD pipeline, facilitating comprehensive integration and regression testing. Regular manual or semi-automatic testing using the Digital Twin is recommended for the best results.

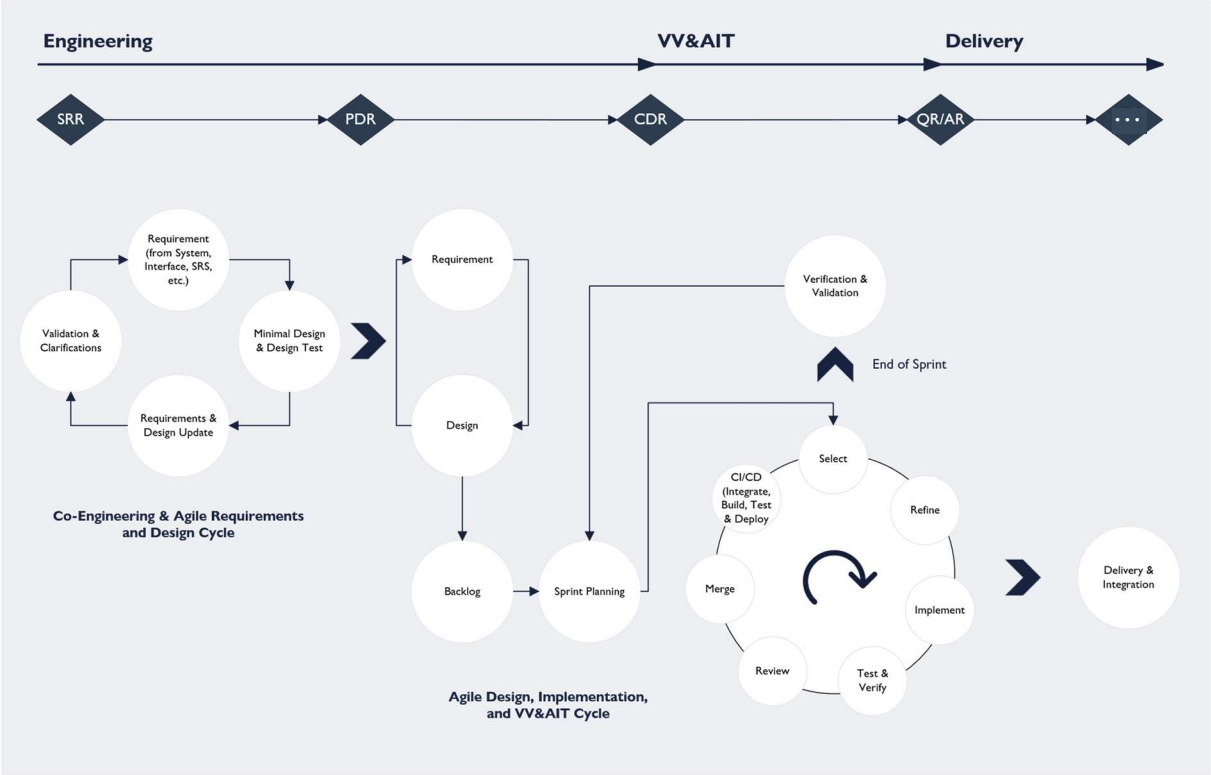

Figure 5: Illustration of our agile approach, encompassing the engineering, development, testing, and delivery phases.

PRODUCTS AND SERVICES

Quantum-Safe Satellite Communication

In collaboration with our partners, we are developing an end-to-end quantum-safe encryption solution compatible with CCSDS Space Packet and SDLS standards. We focus on creating robust onboard components that seamlessly integrate with spacecraft and payload flight software, ensuring secure communications and safeguarding against quantum computing threats. We seek platform partners for precursor missions to advance and demonstrate our encryption technology and processes.

Turn-key Solution to Generate Multi-Platform Communication Protocols

We offer a turn-key solution that generates multi-platform communication protocols to ensure better code, faster deployment, and robust communication systems. By leveraging the well-established ASN.1 specification language, our toolset automatically generates code and documentation in various languages, such as C/C++, Python, Scala, Ada, and HTML. This automation guarantees consistent and error-free protocol implementations, significantly reducing the time and cost of evolving telecommunication standards.

Designed for the rigorous demands of space missions, our solution is fully compatible with CCSDS and PUS-C standards, ensuring seamless integration with space agencies and industry partners and for

various platforms. It supports the rapid deployment of telemetry and telecommand (TM/TC) protocols, enhances interoperability, and allows for adapting and scaling protocols to meet mission-specific needs.

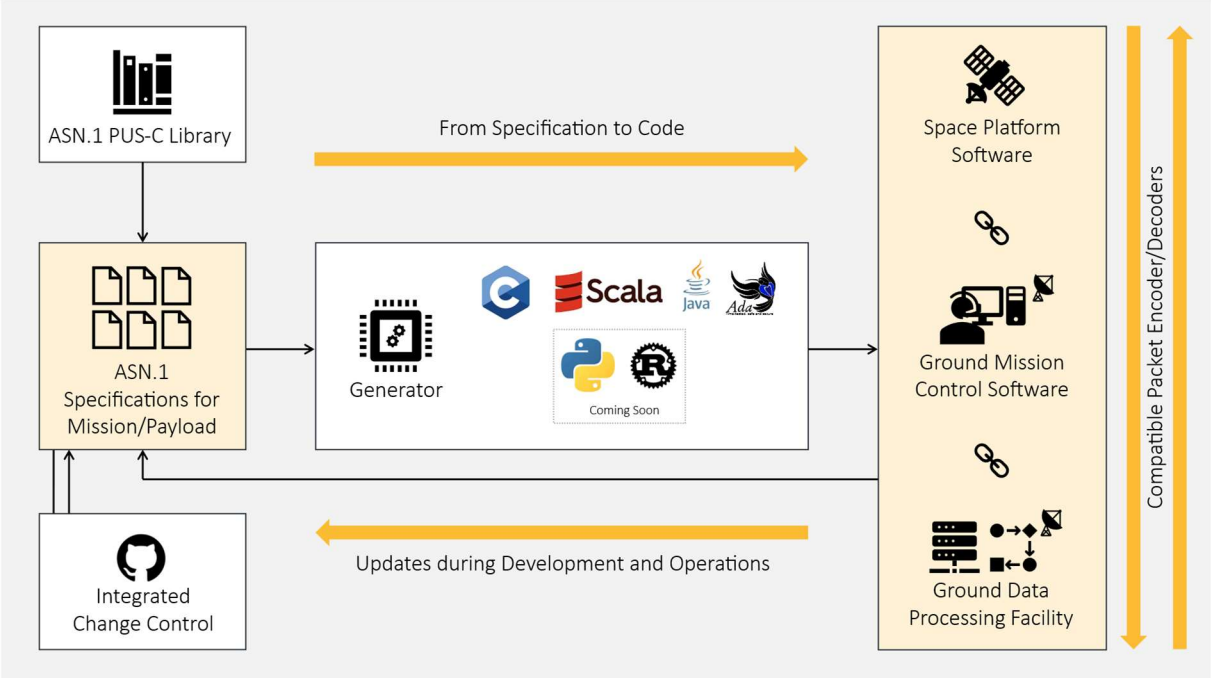

Figure 6: The automated ASN.1-to-Code process allows updates to the protocol specifications to be easily integrated into all software components and version-controlled.

PROJECT SHOWCASE

Embedded Software Development (Ground and Space Segments)

2025 (ongoing, ESA funded) Ateleris is tasked to support the continued development of EGSE software written in C++. The primary focus is on formalizing and implementing a robust scripting language to test and control the software and instruments.

2025 (ongoing, ESA activity, GSTP) In this GSTP activity (number 1000040602), we are extending the ASN1SCC toolchain for ESA, focusing on developing a dedicated Python backend and enabling seamless integration with our consortium partner's ground and flight environments. This activity builds on our previous work under ESA activity 4000140196, where we extended the ASN.1 compiler to generate Scala programs for encoding and decoding data, explicitly tested with TM/TC packets of the PUS-C standard. In the current follow-up, our role includes designing, implementing, and testing the new Python backend, supporting toolchain integration, and addressing consortium-wide interface and interoperability requirements. The ESA contract number for this activity is 4000146882/24/NL/KK.

2023-2024 (completed, ESA activity) ESA project to generate formally verified telemetry packets (ESA activity 4000140196). In this project, an ASN.1 compiler will be extended to produce Scala programs for encoding and decoding data, which will be explicitly tested with TM/TC packets of the PUS-C standard. With the Lab for Automated Reasoning (LARA) at EPFL, the Scala code will be formally verified with Stainless.

2023 (ongoing, ESA Activity, ARTES) The ARTES 4S project started in December 2023 and aims at developing end-to-end quantum-safe security for satellite data links. We focus on developing the PQC-based key exchange and encryption modules for the space segment and integrating them with our partner's ground segment. The consortium has Swiss and German participation. Find more information online at https://www.ateleris.ch/post-quantum-cryptography.

2018 (ongoing, ESA Activity, PRODEX) Starting in 2018, the University of Applied Sciences Northwestern Switzerland FHNW contracted Ateleris to support the flight software verification, testing, and maintenance of the Spectrometer/Telescope for Imaging X-rays (STIX). STIX is one of 10 instruments on board the joint ESA/NASA Solar Orbiter mission, launched in February 2020. Since 2019, Ateleris has also supported the design and development of the ground data processing pipeline and archiving system.

Nicky Hochmuth, Simon Felix, Filip Schramka, and Laszlo Etesi, as members of the STIX core team at FHNW, have been instrumental in the design, development, verification, testing, and operation of the flight and ground analysis software at various stages since the launch of the STIX instrument in 2012. Nicky Hochmuth focused on testing and verifying the on-board processes and algorithms and developed most of the EGSE test scripts. Simon Felix and Filip Schramka redesigned the flight software architecture, developed essential core elements of the flight software, and designed the STIX file system. Laszlo Etesi, a STIX Co-I, continues to lead the flight and ground software efforts, is a core member of the STIX operations team, and played a vital role during the STIX in-orbit commissioning in 2020.

2019/20 (completed) Together with LARA at EPFL, Ateleris conducted a study using formal software verification to develop formally verified embedded software components. As proof of concept, Ateleris rewrote the STIX file system in Scala and then verified it with Stainless to produce a mathematically proven defect-free file system module. The study was conducted as part of the Mesure de Positionnement 2020 (MdP) of the Swiss Space Office, Space Innovation, and ESA. The team submitted a paper to the 2022 NASA Formal Methods conference (Hamza, J., Felix, S., Kunčak, V., Nussbaumer, I., and Schramka, F., 2022, May. From verified Scala to STIX file system embedded code using Stainless. In NASA Formal Methods Symposium (pp. 393-410). Cham: Springer International Publishing).

Edge Computing and AI (Ground and Space Segments)

2022-2024 (Completed) In collaboration with the Institute of Sensors and Electronics FHNW, Ateleris developed an advanced object detection model capable of detecting small objects such as ships in satellite imagery and running it on an embedded hardware-accelerated system explicitly designed for space applications, but applicable to many other applications such as drones or autonomous vehicles. Ateleris curated a training, test, and verification dataset from swisstopo imagery. The machine learning model was trained using quantization-aware YOLOX and compiled using Xilinx tools for execution on a Xilinx UltraScale+ SoM. The final product is an end-to-end demonstrator that reads and processes live camera images and detects objects in quasi-real-time. Research funded by armasuisse S+T.

In a follow-up project, the framework was further improved, leading to an accelerated onboard performance of real-time object detection at a rate of 10.5 megapixels with ~26-watt peak power use, which was demonstrated on board a heavy-lifting drone.

2021 (completed) Ateleris designed and evaluated an image preprocessing pipeline based on TensorFlow lite for execution on embedded platforms like in-orbit payloads or drones. The goal was to observe the necessary steps to calibrate, reconstruct, geo-correct, and geo-project raw data from an optical sensor to use the image for onboard post-processing, analysis, and machine learning. Research funded by armasuisse S+T.

2019 (completed) Ateleris designed an embedded prototype software autonomy algorithm in C for the STIX flight software to autonomously optimize the balance of image quality and telemetry rate requirements. This prototype was implemented in a Swiss Space Center/EPFL Call for Ideas frame.

Platform Development (Ground Segment)

2024 (ongoing, ESA activity, GSTP) In this GSTP Element 1 "Develop" activity, we are migrating the Space Sustainability Rating (SSR) platform to a robust production system based on React (frontend) and .NET (C#) (backend). The SSR enables satellite operators to assess their compliance with space debris mitigation best practices and standards. Our role includes transforming the existing prototype into a scalable, secure web application (RATE-SPACE), enhancing user experience, automating manual workflows, and integrating advanced data analysis and visualization features. We are applying user-centered design methods to gather requirements, iteratively test mockups, and refine system specifications. The development follows agile methodologies with continuous integration and deployment pipelines to ensure rapid feedback and regular delivery of new features. Ateleris works closely with the SSR consortium, including the World Economic Forum, ESA, MIT, BryceTech, and the University of Texas at Austin, to support the platform's evolution into a leading industry standard.

2022 (ongoing, ESA activity, FLPP) We are developing a web platform based on .NET Core and React to create Space Transportation Vehicle configurations and run life cycle analyses for future space missions (Green Space Logistics Analysis Tool). We guided the software lifecycle with UXD methods,

created mockups for early testing, and extrapolated the user requirements and system design specifications from them. We applied an agile software specification, design, and development approach using Continuous Integration and Development pipelines on GitHub. The agile approach allowed ESA to react regularly to intermediate products and maintain steady control over project development. Ateleris is part of a consortium with the EPFL Space Center (eSpace) (project lead) and the Paul Scherrer Institute (PSI). ESA Contracts No. 4000142632/23/FR/KR and 4000137588/22/FR/JLV.

2020 (completed) We supported the development of a Python-based web platform to extend the Technology Comparison and Analysis Tool (TCAT) developed by EPFL for ESA. Our contribution was operationalizing the Python scripts by integrating them into a web application with secured public API web interfaces.

Machine Learning, Algorithms and Decision Intelligence (Various Industries)

2022 (ongoing) We are developing an automatic and optimized scheduling service for delivery vehicles for a leading logistics company in Switzerland. The software computes daily schedules for all drivers and trucks, balancing customer and economic goals while respecting legal and contractual requirements.

2020 (ongoing) We are developing and maintaining computer vision models for feature extraction of 2D engineering plans for a consulting company in Switzerland. The results are used to run large-scale automated pricing algorithms of engineering parts.

2021/22 (completed) Using machine learning models, our team engineered a real-time threat-detection module for a leading US-based cybersecurity company. The client's platform processes over 4 million login requests daily, which are now checked against our algorithm. The models improved accuracy by magnitude over the previous rule-based system.

2019/20 (completed) For our client TestingTime, we developed a matching algorithm based on machine learning models to predict a potential study participant's suitability and dependability. This algorithm outperformed customer satisfaction over the previous manual allocation.

2018 (completed): We developed path-finding algorithms for a healthcare and surveillance robot. These algorithms allow robots to navigate in dynamic environments with moving obstacles reliably. The algorithms were tuned to operate in real time onboard the constrained embedded system.

Signatures and Approval

	Name and Role	Signature	Date
Prepared by	L. Etesi		08.08.2025
Approved by	V. Tamburello		08.08.2025
Release by	L. Etesi		08.08.2025

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Issue/Rev.	**Date**	**Author**	**Reason for Change**
I1R0	10.10.2023	L. Etesi	Rework
I1R1	22.03.2024	L. Etesi	Update
I1R2	03.03.2025	L. Etesi	Update
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Issue/Rev.	**Date**	**Description of Change**	**Paragraph**	**Page(s)**