5/30/2023

FINAL REPORT

Latvian Space Infrastructure Needs Study

ESA Contract No:

4000135671/21/NL/SC

Davids Štebelis

MANAGEMENT SERVICE COMPANY SIA

Contents

1. Introduction

Latvia became an Associate Member of the European Space Agency (ESA) in July 2020. Associate Membership brings challenges and opportunities to Latvian entities to grow their footprint in space. To support the achievement of the goals of the Latvian space strategy, the stakeholders – ESA, the Latvian delegation to ESA, the Latvian Ministry of Education and Science, and the Latvian Ministry of Economics – initiated the "Latvian Space Infrastructure Needs Study" to get a clear picture of the infrastructure issues that may limit the growth of the space sector in Latvia.

The study focused on five types of infrastructure that the Latvian space ecosystem needs to realise its full potential:

- Specialist manufacturing, assembly and integration infrastructure,
- Specialist testing equipment infrastructure such as thermal vacuum chambers, shakers,
- Specialist software tools such as thermal analysis, radiation analysis, supercomputer access,
- Specialist ground stations (for communication, observation, and ranging),
- Satellite data storage.

Latvia is a well-developed country; all essential services, such as broadband connections and electricity, are readily available and of high quality.

Management Service Company SIA implemented the study between November 2022 and May 2023. This report summarises the main findings of the study. It offers recommendations for industrial policy actions and the adaption of financial instruments to meet the needs of the emerging Latvian space industry.

2. Study methodology

The study is based on the primary data collected from the Latvian entities through face-to-face semi-structured interviews. Management Service Company SIA consultants interviewed 15 Latvian entities (see **Table 1**). The study sample accounted for over 87% of the total ESA commitments with Latvian entities. The interviews were carried out between December 2022 and April 2023.

Table 1. The overview of the study sample, classified according to industrial areas

Space hardware and software	Satellite data-based services	Ground stations
Eventech SIA	Institute for Environmental Solutions	University of Latvia, Institute of Astronomy
RD Alfa Microelectronics JSC	Baltic Satellite Service SIA	VIRATEC SIA
Allatherm SIA	Institute of Electronics and Computer Science	University of Ventspils
Latvian State Institute of Wood Chemistry		
Baltic Scientific Instruments SIA		
SMW Group SIA		
Bitlake Technologies SIA		

Cryogenic and Vacuum Systems SIA		
Spatialite Antenna Systems SIA		

The semi-structured interview outline comprehensively covered both:

1) The retrospective data, such as the entities' in-house infrastructure and existing facility-sharing practices and third-party infrastructure, that the entities had accessed or failed to access in the past.
2) The future needs for infrastructure for the space industry in Latvia. The infrastructure gap assessment was based on the entities' short to mid-term (2-7 years) plans in the space domain, manifested in their R&D roadmaps and business plans. In particular, the study focused on four categories (i) specialist testing equipment infrastructure, (ii) specialist manufacturing, assembly and integration infrastructure, (iii) supercomputer infrastructure, and (iv) satellite data resources (e.g., data cubes).

All interviews were post-processed, i.e., fully transcribed for condensing the content into short summaries of critical findings that were distributed to the informants for approval and served as a tool for data triangulation. The data validation phase was carried out in two steps:

- desk research for validating key facts (e.g., matching information from the entities with offerings of external service providers or requirements emanating from relevant ECSS standards),
- fact-checking during data validation meetings, held either in-person or via video-conferencing tools.

Management Service Company SIA team also organised a Round Table meeting in March 2023 for the downstream industry representatives to discuss common challenges of the sector and collect feedback on proposed actions for addressing the problems.

3. Findings and recommendations

2.1. Recommendation 1: Public grants and loans for infrastructure required for qualifying flight hardware

As of 2023, Latvian space companies Allatherm, RD Alfa Microelectronics, and Eventech, along with the Latvian State Institute of Wood Chemistry from the research institutions, have achieved Technology Readiness Level (TRL) 5.

At such a maturity level, companies that considering space product manufacturing, face increasingly complex requirements regarding product and quality assurance and manufacturing processes. At TRL 6, the Engineering Model is developed to demonstrate the end product's critical functions in form fit and function. At TRL 7, the Qualification Model that fully reflects the end product design in all aspects is developed for complete functional and environmental qualification tests to demonstrate the product's performance in the operational environment. Moreover, before starting the Qualification Model, a space company must hold a Manufacturing Readiness Review to evaluate the status of manufacturing, assembly, inspection and test procedures and facilities. Also, personnel involved in manufacturing must be comprehensively trained.

Any company that aspires to manufacture space-qualified hardware must invest heavily in productive assets, assembly and integration facilities, product assurance capabilities, and upskilling of employees to leap from TRL 5 to TRL 7. For example, the tolerances of the out-of-date machines are at a level where it is practically impossible to set up manufacturing procedures that enable fabricating items compliant with the European Cooperation for Space Standardization (ECSS) standards.

To illustrate the needs of a company that qualifies for flight hardware, Allatherm is a good example, committed to the strategic goal of taking their products to space and determined to carry most of the (critical) manufacturing processes out in-house, highlighting the importance of specialised manufacturing infrastructure. Allatherm belong among the technology leaders in Europe in their field of manufacturing and development of specialized products related to thermal management. The study revealed that the short-term investment needs of Allatherm developing space products to prepare for qualifying space hardware could be between 1.5 and 2 million Euros. This includes investments in cleanrooms and upgrading industrial equipment, such as high-accuracy machines, tools, and control systems. Allatherm needs to purchase an electron-beam welding machine, a CT scanner, and high vacuum furnaces to develop and manufacture the Engineering and Qualification Models for Allatherm's thermal management products.

With its strong position in the market, Allatherm is well-positioned to commercialise its thermal management technology. Collaborations with industry leaders like Thales Alenia Space and other Large System Integrators, including OHB System AG, further enhance its potential. Additionally, the technology holds genuine potential for spin-offs in non-space industries, aligning with the priorities outlined in the Latvian Smart Specialization Strategy. The core technology can be adapted for serial production in diverse sectors, including power electronics, vehicle manufacturing, military applications, medical equipment, and thermal control solutions.

However, securing funding for multi-million development projects in the space industry presents significant challenges. Despite high-profile customer demand, these customers typically do not provide binding letters of intent as proof of future revenue streams. This lack of commitment negatively affects the assessment of risk by institutional lenders, resulting in higher interest rates and increased collateral requirements. To overcome these obstacles and capitalise on market opportunities while mitigating financing risks, public support becomes crucial.

Allatherm seeks public support to navigate the complexities of funding and leverage market opportunities effectively. By addressing these challenges, the company can successfully establish itself in the space industry, drive advancements in thermal management solutions, and explore potential applications in various sectors.

Another high maturity level company is Eventech. A leading provider of timers and time-tagging solutions. Currently, Eventech's terrestrial timers are utilised by prominent SLR stations across the globe, including Australia, Japan (Jaxa), the United States (NASA), China, Argentina, Chile, Spain, Portugal, the United Kingdom, Africa, Germany (ESA), Switzerland, Austria, and others. It is worth noting that Eventech's product is recommended by NASA on their official homepage, showcasing its exceptional quality and reliability. While Eventech has primarily focused on terrestrial applications, the company has ambitious plans for the space industry. Although commercial sales for space-related products are not yet available, Eventech intends to introduce altimetry systems after the successful delivery of the HERA mission project. Leveraging their valuable experience in space mission projects, Eventech aims to further commercialise their products, providing innovative solutions for space exploration and beyond. To facilitate planned space development activities it is required to invest more than 670K € in the infrastructure alone. This would help Eventech to

enhance measurement and analysis capabilities, increase accessibility to testing and validation, manufacturing and assembly of space hardware, facilitate rapid prototyping and customisation and improve research and development efficiency.

Finally, RD Alfa Microelectronics, company that is proficient in designing, production and testing microcircuits. One of the notable achievements of RD ALFA Microelectronics is the development of the Quad Operational Amplifier αRD124A, which was successfully qualified for usage in ESA space missions. They aim to ensure the qualification of all their existing products and explore markets outside Europe. They planning to acquire two testing instruments for screening test according to ESCC 9000 to support the production of integrated circuits, investing between 150K €-200K €. Access to infrastructure is crucial for ensuring the quality of integrated circuits and avoiding issues caused by loose particles. As well it will enhance its specialist manufacturing, assembly, and integration infrastructure and ensure the quality of its integrated circuits. The availability of such equipment benefits multiple businesses by facilitating quality assurance, testing, and imaging processes in the space industry and beyond. It also supports the objectives of the RIS3 strategy by fostering positive effects on other industries in Latvia.

The study recommends that the Ministry of Economics consider providing infrastructure investments could be between 2.5 and 3 million Euros, for space hardware manufacturers that qualifying flight hardware. Funding support should be provided through national-level grants, loans, and credit guarantees. This initiative aims to strengthen Latvia's long-term position in the global space industry.

The terms and conditions of the existing and planned financial instruments in Latvia, such as productivity loans for innovative equipment or digital transformation, should be extended and tailored to accommodate the needs of the knowledge-intensive space technology business fully. Such public support stimulates private investment in R&D and helps to overcome the valley of death in the space industry.

3.2. Recommendation 2: Support Irbene ground station's integration into the global marketplace

The antenna site in Irbene, ~30 km north of Ventspils, operated by the Ventspils International Radio Astronomy Center, a research institute at Ventspils University of Applied Sciences, is Latvia's most unique space infrastructure resource, with an estimated replacement value of tens of millions of Euros. The facility's activities revolve around the fully steerable antennas RT-32 and RT-16.

The RT-32 antenna can be used for various purposes, including communication, tracking, and scientific observations. It can facilitate communication between ground stations and satellites or spacecraft by enabling the transmission and reception of signals, ensuring reliable and efficient communication with space-based assets. Additionally, it can be utilized for tracking objects in space, such as satellites, space probes, and space debris, accurately determining their position, trajectory, and movement which in addition to space communication would provide valuable tracking data for orbit monitoring and maintenance. Furthermore, the antenna is employed in scientific research through observations of celestial objects and phenomena, allowing astronomers and researchers to collect data from space e.g. radio signals emitted by distant galaxies, pulsars, and other astronomical sources. By capturing and analysing these signals, scientists gain insights in the nature of the universe, study cosmic phenomena, and advance our understanding of astrophysics.

The 32 m antenna currently is equipped with a cryogenic C-band receiver with its broadband capability covering 4.5 to 8.8 GHz frequencies, a multi-channel Solar spectrum polarimeter, and an L/S band ambient temperature receiver (with a cryogenic upgrade in development), enabling various types of measurements. The RT-16 antenna is equipped with the same type of cryogenic broadband receiver as RT-32, an ambient S-band, and a cryogenic X-band transceiver is currently in development.

The ground station has been used purely for scientific purposes by the Latvian science community engaged in fundamental research in astronomy and astrophysics. Over the years, the international radio astronomy community has shown interest in the Irbene station's capabilities. For example, in 2016 Irbene became a part of the European Very Long Baseline Interferometry Network, a network of radio telescopes which performs very high angular resolution observations of cosmic radio sources and celestial objects. This allows scientists and astronomers to study cosmic radio sources with exceptional accuracy and resolution, providing valuable insights in the properties and behaviour of these sources.

Despite its undeniable potential, the large aperture antennas (32- and 16-meter diameter) at Irbene has not served commercial customers in the global Space Communication Ground Segment market until now. The preparatory activities for launching commercial Telemetry, Tracking and Command (TT&C) services are in progress yet have not been completed. In the context of a ground station, TT&C refers to the processes of collecting and transmitting data, accurately tracking the spacecraft's position and trajectory, and sending commands to control and operate the spacecraft remotely. The site's management is committed to entering the global TT&C market for example by becoming a partner of the ESA Tracking Stations network (ESTRACK), a European strategic infrastructure, ensuring European independent access to space. The station is developing the operational procedures for the commercial TT&C services and compiling a long-term roadmap.

The one-time investment needed in the short term to realize this ambition is close to 1.9 million Euros. This infrastructure is designed to provide antennas with the necessary equipment such as receivers, transmitters, amplifiers, frequency converters and communication back-ends to support the launch of commercial services. With the support of international partners, there are plans to introduce S /X /Ka band satellite communication services to the market. Interest for collaboration in establishing this capability has also been expressed by the Ministry of Defence to strengthen Latvia's capabilities in the space sector. The Latvian government's continued support is required not only to keep the site operational but also to upgrade the large aperture antenna capabilities and unlock the full potential of the infrastructure. The study recommends that the Ministry of Economics and the Ministry of Education and Science consider infrastructure investments for Irbene ground station through national-level grants, loans, and credit guarantees. This initiative aims to strengthen Latvia's long-term position in the global satellite ground segment industry, defence industry and strengthen Latvia's capabilities within NATO.

3.3. Recommendation 3: Affordable access to cleanrooms for the Latvian deep tech sector

Several Latvian companies developing space hardware emphasised the imperative nature of investing in ISO Class 8 / Class 100,000 cleanrooms, necessary facilities for assembly and integration in the upstream space industry. ISO Class 8 / Class 100,000 cleanrooms are controlled environments with a maximum particle count of 100,000 per cubic foot of air, used across various industries, such as pharmaceuticals, biotechnology, electronics, and space technology. These cleanrooms have specialised ventilation

equipment and filters to prevent contamination of products, as even the smallest particles of dust or other contaminants can cause significant damage to sensitive equipment.

Cleanrooms are company-specific production environments. However, multiple study respondents showed interest in the **'cleanrooms-as-a-service'** approach to save on the initial investment costs and streamline operation and maintenance costs. The investment cost of the cleanrooms usually ranges between 2000 and 5000 Euros per sq. m., and even a limited assembly area could cost 0.5 million Euros to a company. According to the 'cleanrooms-as-a-service' operational model, a specialised (space) technology hub or competence centre should invest in the facilities and lab equipment and ensure compliance with cleanroom procedural and maintenance engineers' qualification and training requirements.

The study team proposes an innovative concept of a '**cleanroom incubator'** to be implemented in Latvia to cater to the space industry's needs. To be considered for admission into the cleanroom incubator, a company—not necessarily a start-up—should adopt a new business model that requires an airborne controlled environment, classified according to ISO 14644-1:2015, for product and quality assurance. The incubates can access cleanroom facilities, support services (e.g., of maintenance engineers), and training on favourable terms for a limited period. Within this period, e.g., three years, the company should be able to scale up its new business model. The cleanroom incubator is a knowledge transfer hub where the tenants and their employees learn how to design, build, and operate a cleanroom to space standards. For incubates, the cleanroom incubator is an affordable and low-risk interim step before investing in their own facilities.

The concept of a cleanroom incubator provides crucial support to companies in the research and development stage. While its primary focus is on benefiting Latvia-based space businesses, it also holds significant potential for non-space industries. Several non-space sectors can leverage the advantages offered by the cleanroom incubator to advance their operations and enhance their products.

Firstly, microelectronics companies engaged in the manufacturing and developing microelectronic components, such as semiconductors and integrated circuits, greatly benefit from controlled environments that prevent contamination and ensure optimal product quality. Secondly, industries involved in precision engineering, such as optics, precision mechanics, and aerospace components, rely on high-precision manufacturing processes. Lastly, companies in the biotechnology and pharmaceutical sectors heavily rely on cleanroom environments to manufacture and test of drugs, medical devices, and biologics. The cleanroom incubator allows them to conduct their operations within a regulated and contamination-controlled environment, enabling them to meet stringent regulatory standards.

By extending its benefits beyond the space industry, the cleanroom incubator initiative promotes cross-industry collaboration and innovation. It opens doors for knowledge sharing, technological advancements, and economic growth not only within the space sector but also across key non-space industries. Ultimately, the cleanroom incubator catalyses progress, providing companies in research and development with the necessary resources and infrastructure to thrive and excel in their respective fields.

First, a feasibility study must be conducted to assess the viability and potential success of a proposed initiative. For the cleanroom incubator concept, it is essential to understand potential demand outside the space industry, including the domains prioritised by the Latvian Smart Specialization Strategy. The feasibility study aims to gather and analyse relevant data and information to determine if the cleanroom incubator is technically, financially, and operationally feasible.

The Materize center at the Institute of Solid State Physics, University of Latvia, which already operates cleanroom facilities, is a strong candidate to serve as the host organisation for the cleanroom incubator. They have gained valuable experience in cleanroom operations, maintenance, and customer service, making them well-suited to support the incubator's activities.

By collaborating with Materize, there is an opportunity to expand their existing cleanroom facilities to accommodate the needs of the cleanroom incubator. Based on preliminary estimates, it is anticipated that establishing the cleanroom incubator would require an investment of approximately 5 million Euros from the Latvian state. Additionally, annual allocations for maintenance and engineering support services would be necessary to ensure the smooth operation of the incubator and provide ongoing assistance to the participating companies.

The study recommends that the Ministry of Education and Science consider offering infrastructure investments for the cleanroom incubator through national-level grant programs. It suggests implementing financing programs to support research infrastructure development in alignment with the knowledge specialisation areas of the RIS3 strategy introduced by the Ministry of Education and Science.

3.4. Recommendation 4: Development of the national Earth Observation platform

Centralised satellite data storage and management has been a prominent discussion topic in Latvia for several years. Entities developing new Earth Observation (EO) solutions face common challenges, particularly in data acquisition and resource-demanding pre-processing. However, despite the apparent duplication of efforts to solve the issues, the ecosystem has yet to harness the potential for collaboration and cooperation.

The study confirmed that entities in the downstream industry see value in establishing a centralised satellite storage and cloud computing platform in Latvia. The platform should collect data required by Latvian organisations and institutions to develop commercial EO solutions, including analysis-ready data tailored to the needs of Latvian public agencies. Ensuring rapid and timely availability of the Copernicus data would be just one feature of the system. More importantly, the platform should provide access to auxiliary geospatial data, such as in-situ reference data and publicly available open data in Latvia.

This study calls for a meticulously planned feasibility study of the EO platform. The study mapped the expectations of the developers of new EO applications (the supply side of the EO market). In contrast, earlier studies (e.g., PwC, 2022[1]) have dealt with the public sector stakeholders' needs in Latvia (a part of the demand side). A dedicated feasibility study must be conducted to align these needs and expectations and refine them into the functional requirements of the EO platform.

First of all, the EO platform should be complementary to the existing counterparts in Europe and planned initiatives in the region. For example, the Estonian EO data hub EstHub[2] collects Sentinel-1-2-3 data for the whole territory of Latvia. Therefore, it is cost-efficient for the Latvian EO community to take advantage of ESTHub's high-quality services. On the other hand, ESA procures the EO Baltic Platform for Governmental Services in the second quarter of 2023. The winning consortium faces the task of identifying the

[1] PricewaterhouseCoopers SIA (2022);"*Pētījums par brīvpieejas satelītdatu izmantošanas iespējām Latvijas publiskā un privātā sektora institūcijās*", Final Report of the public procurement contract No. 2-6.1e/21/30; Riga; 123 pages.
[2] https://ehdatahub.maaamet.ee/dhus/#/home

components and capabilities already available in the Baltic states that can be reused and integrated into the EO Baltic Platform to develop value-adding services for public sector customers.

The Latvian EO platform must balance the needs of the industry and public sector, academia and companies, and expert users and students. For example, the EO platform could provide a sandbox environment (experimental environment for proof-of-concept development) for students and start-ups to test service ideas on customers. Focusing on new users would mean developing an intuitive user interface for the platform. EO platform focus should be on creating software components/middleware enabling actionable open data. The latter concept has been defined as the data that (i) are offered in an open and consistent format; (ii) generate relevant re-use; (iii) embed mechanisms for interaction and integration in all phases of the data value chain, including the design, mining, analysis, and visualisation; (iv) enable data agency by promoting data literacy—including access to data, skills, means, and opportunities—among stakeholders; (v) encourage alliances among various sectors for open data re-utilisation with social aims; and (vi) respond to citizens' and organisations' needs and interests.

The feasibility study should initiate a broader discussion on the roles of public agencies and enterprises in developing the Latvian EO ecosystem. According to the industrial players, public sector organisations should be more ready to regularly procure solutions from businesses instead of the prevailing practice of internalising EO-based R&D activities. The cost of the feasibility study is between 30 and 50 thousand Euros.

According to the interviews with the Latvian downstream industry, the Ministry of Environmental Protection and Regional Development, coordinating the development of geospatial data infrastructure in Latvia, should assume the responsibility for creating the EO platform. Considering VARAM's activities in digital administration, sustainable management of natural capital, and climate, EO platforms serve as suitable tools for achieving VARAM's goals including: (1) Developing state service management and customer service capabilities through the use and development of new technical platforms; (2) Opening up state administration data and platforms to ensure data content compatibility; (3) Establishing unified state ICT management by improving the legal framework and ICT architecture; and (4) Assessing and monitoring priorities such as preserving and improving environmental quality (air, water, and sea). Additionally, EO platforms play a crucial role in addressing climate change mitigation, adaptation, and biodiversity conservation.

Based on international benchmarks, the investment cost of developing the EO platform combining various satellite data with in-situ reference data and cloud computing capabilities starts from €0.5 million. However, the platform's price will depend on the system's cloud computing capabilities, which are essential as a data download paradigm becomes obsolete, i.e., end-users increasingly process data in cloud environments. An EO platform is a comprehensive solution that offers storage capabilities for managing vast amounts of Earth Observation (EO) data, computing resources for processing and analysing data, and networking infrastructure for seamless data transfer. It also provides users with a suite of tools, frameworks, and APIs, empowering them to develop, deploy, and customize EO-related applications, perform data processing and analysis tasks, and integrate diverse services and datasets.

The study concludes that EO platform in Latvia will result in the following benefits:

- Rapid and Timely Availability of Copernicus Data: quick and timely access to Copernicus data. This benefit is crucial for stakeholders who rely on up-to-date and accurate satellite data for their applications. As well, centralizing data storage has the potential to reduce costs associated with these activities for stakeholders.

- Enhanced Data Accessibility: By integrating in-situ and open data with EO data into a single database, stakeholders would have improved access to a wide range of data sources. This includes proprietary datasets, open data from government sources and international organizations, customer datasets, scientific data, and crowdsourced data. Access to diverse data sets enables stakeholders to develop more comprehensive and accurate value-added services.
- Economies of Scale: By consolidating pre-processed satellite data from various sources, the centralised hub enables the realisation of economies of scale. This means that agencies and stakeholders under the supervision of the Ministry can pool their data needs together, potentially leading to cost savings in purchasing data from commercial suppliers.
- Lowered Entry Barriers: The EO platform would significantly reduce the entry barriers for new industry players by saving time and resources spent on data pre-processing efforts. This benefit allows startups and smaller entities with limited resources to focus on developing innovative EO solutions and applications, rather than investing heavily in data processing infrastructure.
- Promotion of EO Solutions: The centralised EO platform, potentially can expanded into a Centre of Excellence (CoE) in EO solutions, would concentrate relevant knowledge, skills, and infrastructure resources in one place. This concentration of resources promotes the diffusion and adoption of EO solutions in Latvia, primarily in the public sector.