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Growing the Local Space Workforce through Synergistic Collaborations of the Philippine Space Agency, Universities, and Private Industry

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ABSTRACT

For decades, space technology and applications development have been in the forefront of human advancement. To maximize the gains from these achievements, numerous countries have established space agencies to manage the growing space economy. However, for emerging space countries, the establishment of a space agency and a complementary space ecosystem proves to be a more complex and challenging task.

In this paper, we present a review of lessons learned in building up the local upstream space workforce in the Philippines through various projects spearheaded by the government, mostly through the Philippine Space Agency (PhilSA).

For the projects in collaboration with universities, this paper discusses the importance of providing training programs, scholarship opportunities, research and development activities, and promotion of current Space Science and Technology capabilities to create a young pool of knowledgeable personnel.

On the other hand, collaborations with the local industry provide a support to ongoing satellite development activities in PhilSA. Established companies specializing in space-adjacent activities such as those in the manufacturing, electronics, and software development have immense potential in transitioning to actual space development activities. The paper highlights the lessons learned from PhilSA's ongoing collaborations with these companies, and how such engagements translate to a more skilled space workforce.

This paper summarizes the challenges faced, milestones achieved, and how the lessons learned are applied to the current activities in PhilSA and form strategic plans. These lessons learned can be helpful to other emerging space nations looking to ramp up capacity building and establish a thriving space ecosystem.

INTRODUCTION

Space technology and its applications have played a pivotal role in advancing human civilization for several decades. From satellite communications and weather forecasting to global positioning systems and space exploration, the realm of space has continuously pushed the boundaries of human achievement. Recognizing the immense potential and economic benefits associated with space activities, many countries have taken the initiative to establish dedicated space agencies. These agencies serve as the focal point for managing and harnessing the growing space economy.

While established spacefaring nations have benefited from the experiences and infrastructure developed over the years, emerging space countries face unique challenges in establishing their own space agencies and building a complementary space ecosystem. The task of creating a robust space agency involves intricate planning, strategic partnerships, and investment in human capital to ensure that the efforts are sustainable.

For emerging space countries, the path towards establishing a sustainable space ecosystem involves overcoming several hurdles. These challenges include limited financial resources, a lack of indigenous expertise, technological gaps, and competing national priorities. Building a space economy from scratch requires a comprehensive understanding of the complexities involved and the ability to navigate through political, economic, and technological constraints.

This paper aims to delve into the experience, lessons learned, and challenges faced by the Philippines during the initial years of the Philippine Space Agency (PhilSA) in developing a supportive space ecosystem, especially in the upstream sector. By understanding the challenges, milestones, and strategies employed by

PhilSA, valuable insights can be gained to inform and guide future capacity-building efforts in the global space arena.

PhilSA Background

The Philippine Space Agency (PhilSA) is the national space agency of the Philippines. It was established on August 8, 2019, with the signing of Republic Act No. 11363, also known as the Philippine Space Act. The creation of PhilSA marked a significant milestone in the country's efforts to advance its space capabilities and participate in the global space community.

As a new agency, PhilSA aims to promote the peaceful and responsible use of space science and technology for national development. It is tasked with developing and implementing policies, plans, and programs that foster the growth of the Philippine space sector. The agency's overarching goal is to harness space science and technology for key development areas (KDAs) namely national security and development, hazard management and climate studies, space research and development, space industry and capacity building, space education and awareness, and international cooperation.[1]

Figure 1: Key Development Areas (KDAs) of PhilSA

By forging partnerships and collaborations, PhilSA aims to leverage expertise and resources to build a robust space ecosystem in the Philippines. The agency is involved in various space-related initiatives as guided by its KDAs, including satellite development, space research, capacity building, and international cooperation.

These various projects have not only demonstrated the country's technological capabilities but have also provided opportunities for training and collaboration with local universities and industry players.

PhilSA also plays a crucial role in policy formulation, ensuring that space activities align with national priorities and adhere to international agreements and guidelines.

With its vision of a Filipino nation bridged, uplifted, and empowered through the peaceful uses of outer space, PhilSA is committed to fostering innovation, developing local talent, and positioning the Philippines as an active player in the international space community.

SPACE-RELATED ACTIVITIES BEFORE PHILSA

Fortunately, although PhilSA is a new space agency, it is not building from scratch as there have been multiple space-related projects that have paved the way for the establishment of PhilSA. These Projects are shown in Figure 2 below.

Figure 2: List of Projects Before the Establishment of PhilSA

The space-related projects before PhilSA cover both Upstream and Downstream activities but this paper will focus on the Upstream projects, namely PHL-MICROSAT and the STAMINA4Space Project.

PHL-MICROSAT and STAMINA4SPACE Projects

The PHL-MICROSAT Project is a collaborative initiative between Japanese universities, Tohoku University (TU) and Hokkaido University (HU), and the Philippine government through the Department of Science and Technology (DOST) and the University of the Philippines Diliman (UPD). Its primary objective was to facilitate technology transfer and develop microsatellite technology for earth observation. In pursuit of this goal, the program aimed to construct,

launch, and effectively utilize two microsatellites, namely Diwata-1 and Diwata-2, over a span of three years starting in 2014. Filipino students and engineers were sent to TU and HU, where they received guidance and expertise from Japanese professors in the development of these microsatellites.

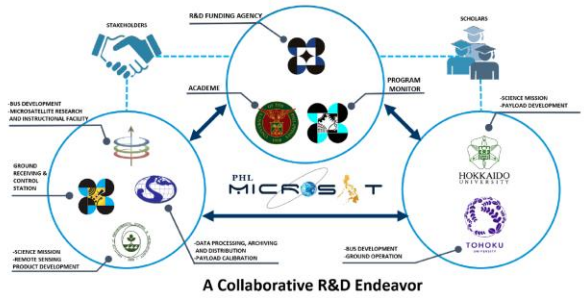

Figure 3: PHL-MICROSAT Program Framework

Beyond the construction of the Philippines' own microsatellites, the program sought to foster advancements in space technology through capacity building and the establishment of a ground station network. The PHL-MICROSAT Project concluded in 2019 and was succeeded by another program, the Sustained Support for Local Space Technology and Applications Mastery, Innovation, and Advancement (STAMINA4Space). STAMINA4Space aimed to build upon the research and capacity-building activities initiated by the PHL-MICROSAT Project, with a particular focus on the localization of satellite development and operations.

The STAMINA4Space saw the development of four additional cube satellites Maya-3, Maya-4, Maya-5, and Maya-6, this time locally in the University of the Philippines by graduate students which were specializing on a nanosatellite track.

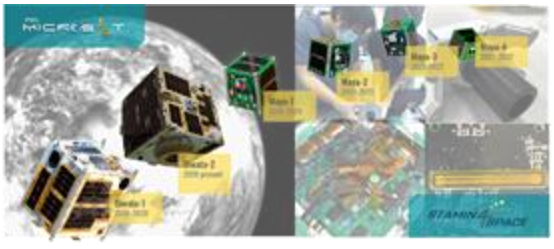

Figure 4: Philippine Satellites Launched Through the PHL-MICROSAT and STAMINA4Space Projects

STAMINA4Space also made possible the development of Engineering Models of camera payloads and satellite bus modules, both implemented locally in the Philippines and designed to be integrated to a 50-kg class microsatellite. These efforts are aligned to the localization efforts for the Diwata class satellites previously developed in Japan with Japanese partner universities.

The STAMINA4SPACE Program ended in 2023 with the completion and launch of the Maya-5 and Maya-6 cube satellites.

UPSTREAM CAPACITY BUILDING PROJECTS IN PHILSA

PhilSA Internal Capacity Building

PhilSA established a framework for the transition of Space Science and Technology Applications (SSTA) capabilities, programs, and/or facilities for the agency to initiate, develop, implement, and enhance SSTA programs either on its own or together with other institutions.

Training programs were conducted such as the delivery and training of the Flexible LEO platform, where PhilSA engineers were capacitated to perform in-the-loop hardware simulation of satellite subsystems.

One such project under the SSTA framework is the Adoption of OPTIKAL and PHL-50 Developed Technologies (ADOPT) Project. ADOPT was conceptualized to contribute to the SSTA research and development capabilities of PhilSA by collaborating with the University of the Philippines Diliman (UPD), which have been involved in SSTA activities in previous years, through the PHL-MICROSAT and STAMINA4Space Programs.

With ADOPT, PhilSA is building upon past and current gains in space R&D investments in the Philippines from the PHL-MICROSAT and STAMINA4Space Programs, specifically the know-how acquired in building satellite payloads and bus components. Transitioning the technologies, as well as the capabilities in hardware and software development and testing into PhilSA is aimed to improve PhilSA's capabilities in terms of satellite development.

It was also strategically planned to become a seed project that can spur further collaborations between PhilSA and UPD, such as UPD-PhilSA co-managed facilities, where PhilSA personnel can freely access the university laboratories while working on space technologies development, as well as receive training from the university, taking advantage of the expertise developed in the university. At the same time, the

universities can actively participate in development activities of PhilSA, providing more value to knowledge developed in the universities.

An example of the co-managed facilities was in the planning of a Vibration Testing Facility. There was an existing specification that the Vibration Facility was initially planned to cover, but in order to maximize the usage of such a development, PhilSA coordinated with more than 12 other entities, companies, and research organizations to design a facility that could be used for spacecraft uses, while being useful as well for the industry and local research and development teams that cover several sectors including aerospace, electronics, technical education, and university R&D laboratories.

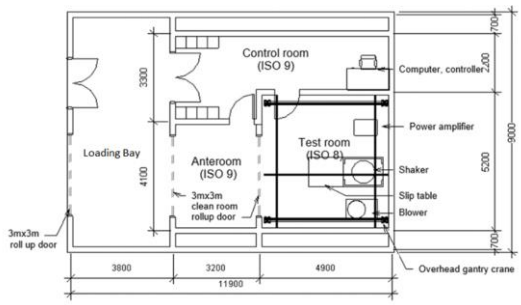

Figure 5: Finalized Design of Vibration Facility

These resulted in modifications in the design, optimization of the location to where it will have the greatest demand and studying the expected demand of the entities that have been a part of this planning process. This kind of study gives confidence to the Philippine Space Agency that the facility will sustain itself from the testing fees, and this method of planning, collaboration with universities such as UPD, and development is expected to continue for facilities that are required in assembly, integration, and testing.

Through the collaboration formed with the Metals Industry Research and Development Center - Advanced Manufacturing Center (MIRDC - AMCen) from STAMINA4Space, PhilSA has built on this engagement through the development of various 3D-printed satellite components as see in Figure 6.

A PhilSA project, Research on Advanced Manufacturing Methods and Products (RAMMP), is implemented to produce flight-ready additively manufactured components and conduct research studies relating to the utilization and advancement of additive manufacturing processes, materials, and products. This will provide guidance in the development of our local manufacturing industry in parallel with other international space agencies and manufacturers. The 3D-printing capacity provided by this MIRDC - AMCen will also assist ongoing PhilSA projects that involve satellite development, most especially for rapid prototyping. In return, PhilSA is providing MIRDC – AMCen a platform to identify advancements in the field of advanced manufacturing due to the global trend of utilizing additive manufacturing for cost-cutting spacecraft development.

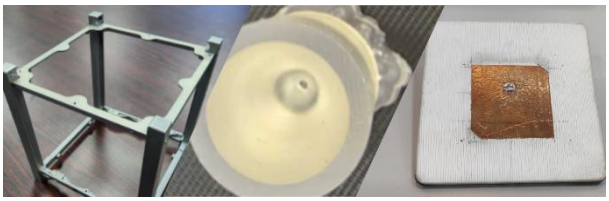

Figure 6: 3D Printed components produced by the RAMMP Project (from left to right: Cube Satellite Frame, Propulsion System Nozzle, Patch Antenna [2,3,4])

Capacity Building with the Academe

PhilSA implements programs and initiatives aimed at enhancing the Philippines' space research and development (R&D), education, and awareness. PhilSA advances space education and awareness by institutionalizing the AD ASTRA Scholarships program, which provides scholarship grants to outstanding Filipinos to pursue graduate degrees in SSTA fields. It also conducts space education and outreach activities with basic and higher education institutions, as well as local competitions on nanosatellite missions and space exploration experiments in partnership with international institutions. These efforts contribute to establishing a sustainable pool of space scientists, engineers, educators and professionals in various disciplines of SSTA, which is crucial to developing a viable domestic space industry.

To achieve both space R&D and educational objectives, the Agency leverages the potential of small satellite technologies, particularly nanosatellites like CubeSats. These nanosatellites, known for their cost-effectiveness and manageable complexity, serve as ideal platforms for satellite missions focused on education, training, research, experimentation, and technology demonstrations. They have played a significant role in disseminating satellite technology and space engineering expertise, particularly within academic communities and among developing nations venturing

into space activities. While their primary purpose is often educational or research-oriented, nanosatellites have also demonstrated their capabilities in operational missions, contributing to various commercial applications and services.

In the Philippines, nanosatellites have been instrumental and presents further opportunities for advancing the country's space R&D, education, and awareness efforts, building upon the achievements and gains of previous R&D projects, particularly the Space Science and Technology Proliferation through University Partnerships (STeP-UP) Project under the STAMINA4Space Program. Through the Expanding Nanosatellite Collaborative Research And Development and Educational Efforts in the Philippines Project (ENCRADLE Project), PhilSA undertakes collaborative R&D, educational training, and know-how sharing initiatives on nanosatellite engineering with Philippine universities. These are aimed at proliferating know-how, promoting academic R&D, and fostering collaboration in nanosatellite systems engineering among universities, as well as training the next generation of space engineers, in the country. Through the project, PhilSA facilitates activities that cultivate collaborations or partnerships among universities and encourages them to engage in nanosatellite R&D projects, with the goal of proliferating space engineering activities and nanosatellite technology in the country.

The ENCRADLE Project also contributes to the production of local graduates equipped with advanced know-how in nanosatellite engineering. This is done through ACCESS Nanosat Project, a component educational project of ENCRADLE Project that provides graduate student-scholars of a premier national university hands-on experience in the overall satellite development process with the mentorship of the Agency's space engineers and scientists. The main project output is the design, build, launch and operation of a 2U CubeSat called the Maya-7 that will be accomplished in collaboration with the four university teams who won the Nanosatellite Mission Idea Contest (NMIC) organized by PhilSA in 2022. Specifically, the NMIC teams focus on the design, development, and subsequent integration of a mission payload with the satellite developed by the ACCESS team, while being involved in the project activities and discussions to grasp the entire satellite project life cycle. ACCESS Nanosat enables mastery of the entire satellite design and development process locally, tapping local companies for satellite parts sourcing and manufacturing, while also nurturing inter-university nanosatellite R&D collaboration. These are expected to bolster the country's indigenous capabilities in nanosatellite research and development.

Figure 7: Photo opportunity during the Maya-7 Mission Design Review held on December 2022, with PhilSA officials and researchers, ACCESS Nanosat Team, NMIC Teams, and external reviewers

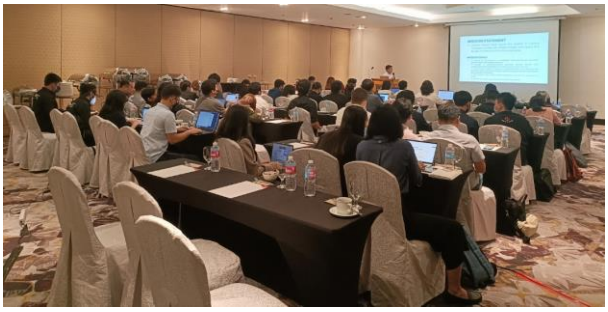

Figure 8: Photo taken during the Maya-7 Mission Design Review

Capacity Building with the Local Industry

The involvement of the private sector in spacefaring nations is vital in maintaining a robust space economy. This is evidenced by the growing participation of companies in space activities. PhilSA realizes that the involvement of local industries, especially those that are already existing in the field of manufacturing, electronics, and software development, a group we collectively refer to as "space-adjacent", is vital to support the Philippines' future space activities.

A pioneering program to support this aim is the Integrated Development of a Unified Standard 3U System (InDUS3US) project, which is a 3U satellite mission combined with a training program. InDUS3US was designed for engineers in space-adjacent companies, giving them an overview of what goes into developing products for space. Through this project, twenty (20) engineers from ten (10) local space-

adjacent companies were partnered with PhilSA engineers to work on a satellite design up to a Preliminary Design Review (PDR) level. This project was held for seven (7) months, starting with lectures on the different satellite subsystems and space environment and followed by the actual satellite design. The PDR was successfully held last December 2022, where an external panel of experts reviewed the industry engineers' work on their respective subsystems along with their PhilSA counterparts.

Figure 9: InDUS3US Preliminary Design Review PhilSA Mentors and Industry Engineers from Partner Companies

During the project, PhilSA technical and business development personnel visited the participating companies to assess their readiness and suitability to manufacture space components. Each company demonstrated their capacity to design and manufacture products based on the requirements and tolerances projected for a small satellite project, such as InDUS3US and previous satellite missions conducted in the Philippines. Another important objective of this project, therefore, is for these companies to gain flight heritage through this satellite mission and demonstrate their capacity.

ACHIEVEMENTS AND LESSONS LEARNED

The experience and the different expertise areas that were developed in the various satellite development projects in the Philippines led to the ability to formulate a satellite development roadmap for the next seven years until 2030. This satellite development roadmap serves as a comprehensive and strategic guide to excel in space technology. It outlines the necessary steps, milestones, and objectives to develop and operate satellites successfully. By providing a clear vision, PhilSA can allocate resources to maximize the promotion of collaboration and enable the Philippines to leverage the immense potential of satellites for scientific, economic, and societal advancements.

Figure 10 shows the PhilSA Satellite Development Roadmap as of 2023 summarizing the different satellites that are planned to satisfy different objectives ranging from education and capacity building to operational and commercial satellites capable of providing a reliable data stream for operational applications through our downstream colleagues.

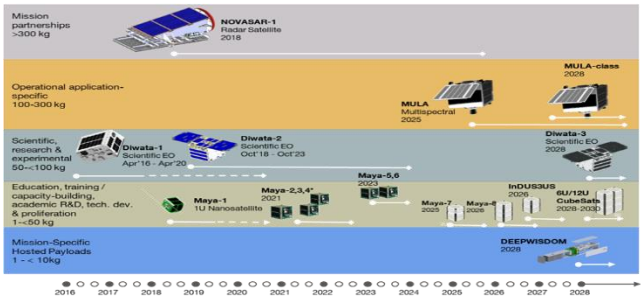

Figure 10: PhilSA Satelite Development Roadmap

Through various projects and collaborations, PhilSA is cultivating a pool of knowledgeable and skilled workforce by leveraging partnerships with universities, private institutions, and the local industry.

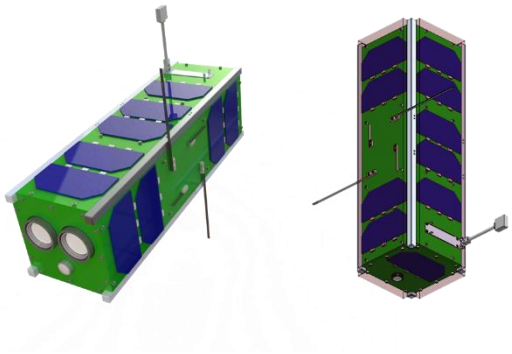

Figure 11: Rendered Model of the 3U Cubesatellite Developed Up to PDR Level in the InDUS3US Project

The results of these capacity building initiatives in the upstream sector are evident in the outputs such as the localized satellite bus modules, engineering and flight models of camera payloads, development of cube satellites, both with university students and researchers and industry players, and the progress of setting up infrastructure to support these localized activities.

With these achievements come the challenges when setting up a new space ecosystem and the lessons learned that can be shared to other countries that are also in the process of establishing their own space activities in their respective countries. These lessons

can serve as valuable insights for countries seeking to ramp up their capacity building efforts.

Strategic Planning: A clear and well-defined vision, supported by a long-term strategic plan, is essential. It should outline objectives, priorities, and the desired outcomes of the space program, aligning them with national development goals. For PhilSA's case, this is embodied in the satellite development roadmap to consolidate the goals for each spacecraft class and their specific objectives and timelines.

Collaboration and Partnerships: Building a space ecosystem requires collaboration among various stakeholders, including government agencies, academia, industry partners, and international organizations. Collaborative partnerships enable knowledge sharing, resource pooling, and technology transfer, fostering innovation and efficiency. PhilSA ensured to tap the expertise of well-established government agencies for infrastructure and expertise that can be translated to space. The same is true for the industry through the collaboration with space-adjacent companies.

Skilled Workforce Development: Investing in the development of a skilled and knowledgeable workforce is crucial. This includes providing training programs, scholarship opportunities, and research and development activities to cultivate a talent pool that can drive space-related initiatives.

Infrastructure and Facilities: Establishing the necessary infrastructure and facilities, such as research laboratories, testing facilities, and ground stations, is vital. Adequate infrastructure supports satellite development, testing, and operations, enabling the country to have independent space capabilities. Though still in its early stage, PhilSA started with feasibility plans on the establishment of space environment testing facilities in the country. The next step is to put the findings of the feasibility plans into action. In the VIBRATE Project, it has been learned that satellite development is not always enough to sustain the operations of AIT facilities. Collaboration with the country's existing industry and being open to modifying specifications to best fit the growth areas of adjacent is particularly important, as it creates a practical approach to the capacity building of the local space industry.

International Collaboration: Engaging in international collaboration is beneficial for knowledge exchange, technology transfer, and fostering diplomatic relations. Partnering with established space nations can provide valuable guidance, support, and access to resources. The Philippines jumpstarted the development of upstream capabilities by partnering with Japan in building our very first satellites. These then became the baseline in building the workforce.

Public Engagement and Awareness: Building public engagement and awareness is crucial to garner support and create a positive perception of the space program. Communicating the benefits, potential applications, and societal impact of space technology can inspire interest and attract talent.

Incremental Approach: Taking an incremental approach allows for gradual development and learning from each phase. Starting with smaller-scale projects and gradually expanding capabilities mitigates risks and enables the accumulation of experience and expertise. The Philippines started with microsatellites and cubesatellites. Once these were successful, the engineers were more confident to develop bigger and operational level satellites.

Sustainability and Continuity: Ensuring long-term sustainability and continuity of the space program requires consistent funding, political support, and a robust talent pipeline. It is essential to maintain momentum and adapt to evolving technological and economic landscapes. PhilSA is doing this by maintaning a good relationship with various sectors in the Philippines and maintain support.

CONCLUSION

Developing a nascent space industry and a robust space R&D sector is a complex process, but the emphasis on collaboration creates pathways that are easier to push through step by step. This process has been influenced by the partnership environment that the DOST-PCIEERD fostered during the PHL-MICROSAT and STAMINA4Space years, and it is certainly an environment we continue today as the Philippine Space Agency. Often, the collaboration pushes the projects in ways that are not expected in the initial planning phases, but these kinds of changes are welcome as it incentivizes the operation of PhilSA to be in harmonious beat with the local universities, research organizations, and industry. This harmonious beat produces successes such as the completed INDUS3US that capacitates the industries, ENCRADLE which capacitates the universities, and the ADEPT and ADOPT frameworks which capacitates the people under PhilSA's umbrella. These improvements in capacity and research and development cascade into the other services we can provide for national security, space awareness, hazard management, and international cooperation.

Each of these efforts contribute to small steps as we are forging ahead, guided by our vision – a Filipino nation bridged, uplifted, and empowered through the peaceful uses of outer space, and our mission to promote and sustain a robust Philippine space ecosystem that adds and creates value in space for and from Filipinos and for the world.

Acknowledgments

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References

1. Philippine Space Agency, "https://philsa.gov.ph/about/#mandate", accessed June 7, 2023.
2. Mabini, G.K., Ante U., Padaca J.B. III, Geraldo E., Del Rosario M. Jr, Ng, A.O. Labrador J. L., Buison A., Sarmiento V, "Mass Reduction, Design Optimization, and Verification of a Nano Satellite Frame Structure." European Conference on Spacecraft Structures Materials and Environmental Testing (ECSSMET 2023), Toulouse, 2023.
3. Rosimo N.O.T., Coronado L.O.B., Mabini G.K., Ibarra J.K., Pugal R., Ng. A.O., "Design of a 3D-Printed Cold Gas Propulsion System for Cubesats," European Conference on Spacecraft Structures Materials and Environmental Testing (ECSSMET 2023), Toulouse, 2023.
4. Del Rosario M. Jr, Rodriguez J., Ballesteros L.I., Mabini G.K., Novabos N.P., Ante U., Florante D.D., Buison A., Yu M.A., Labrador J.L., Paet L.B., Talampas M.C., "Space Qualification and Performance Verification of a GPS Patch Antenna Fabricated Through Hybrid Manufacturing," European Conference on Spacecraft Structures Materials and Environmental Testing (ECSSMET 2023), Toulouse, 2023.