

# **Small Payload Integration and Testing Project Development**

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## Abstract

The National Aeronautics and Space Administration's (NASA) Kennedy Space Center (KSC) has mainly focused on large payloads for space flight beginning with the Apollo program to the assembly and resupply of the International Space Station using the Space Shuttle. NASA KSC is currently working on contracting manned Low Earth Orbit (LEO) to commercial providers, developing Space Launch System, the Orion program, deep space manned programs which could reach Mars, and providing technical expertise for the Launch Services Program for science mission payloads/satellites. KSC has always supported secondary payloads and smaller satellites as the launch provider; however, they are beginning to take a more active role in integrating and testing secondary payloads into future flight opportunities.

A new line of business, the Small Payload Integration and Testing Services (SPLITS), has been established to provide a one stop shop that can integrate and test payloads. SPLITS will assist high schools, universities, companies and consortiums interested in testing or launching small payloads. The goal of SPLITS is to simplify and facilitate access to KSC's expertise and capabilities for small payloads integration and testing and to help grow the space industry.

An effort exists at Kennedy Space Center to improve the external KSC website. External services has partnered with SPLITS as a content test bed for attracting prospective customers. SPLITS is an emerging effort that coincides with the relaunch of the website and has a goal of attracting external partnerships. This website will be a "front door" access point for all potential partners as it will contain an overview of KSC's services, expertise and includes the pertinent contact information.

## **Introduction**

Small Payload Integrated Testing Services (SPLITS) is a new line of business created by the NASA Engineering and Technology Directorate at Kennedy Space Center. SPLITS will tie together the expertise of the personnel and unique technical capabilities that KSC can offer to private companies, academic institutions as well as other government agencies. SPLITS will focus on providing end-to-end capabilities for development, testing, and launching of small payloads (less than 100 kg). The challenge of modifying NASA’s past business model is to identify and convey to academia, industry, government, and other NASA centers what personnel expertise and capabilities are available to help them access space. The SPLITS mission and vision statement are presented in Figure 1.



*Figure 1 SPLITS Mission and Vision Statement*

I was assigned to the SPLITS team to update content from various KSC’s laboratories and identify potential partnership opportunities for future business. In addition to the SPLITS team work, I supported the Center Planning and Development Directorate’s development of an overhaul of the KSC Partnership website. The KSC Partnership website is being designed to guide potential customers to work with KSC.

## **Work Assigned**

### **Small Satellites Systems Webpage Description**

I was tasked with developing the content for the SPLITS webpage on the KSC website. I visited many of KSC’s laboratories and discussing the current capabilities with the lab mangers. I then gathered the information from the laboratories and put it into the new KSC webpage. We also provided the website team with updated images and written descriptions to explain what KSC offers for testing and integration services. Specifically, this involved structuring the layout of the SPLITS webpage including the description. In conversations with the SPLITS team, the selected wording for the SPLITS webpage is shown below.

“Kennedy Space Center’s (KSC) Small Payload Integrated Testing Services (SPLITS) is available to assist customers with end-to-end capabilities for successful development, testing, and launch of small payloads (less than 100 kg). This assistance includes addressing “business case” technical challenges and barriers and facilitating test flight opportunities for qualifying critical space technologies. The SPLITS team draws from a strong experience base to provide a suite of services that can be used individually, or integrated into an end-to-end mission.

One way to flight-test technologies faster is to use small payloads, that is, those weighing less than 100 kg. Small payloads include microsattellites, nanosatellites, and picosatellites. One special class of nanosatellites—the CubeSat—has received a lot of attention and emphasis. A CubeSat is a standardized 10 cm cube weighing less than 1 kg. Each 10 cm cube is “one unit” or a “1U” form factor in the “CubeSat world,” and CubeSat missions can consist of several integrated 1U cubes (2U, 3U, 6U or even 12U). The standard size of a CubeSat has led to a set of standardized deployment mechanisms for use on missions with either small or large rockets. On larger rockets, CubeSats would be secondary or auxiliary payloads taking advantage of unused launch mass. The SPLITS team can assist with all three types of small payloads, including CubeSats.

Drawing on hands-on experience with the integration of payloads for missions in space, and on experience with small-scale flight tests (balloon and suborbital), the SPLITS team can provide the following services:

- Rapid prototyping support to handle the space launch environment
- Modeling and design visualization
- Material and parts selection
- CubeSat fabrication and assembly
- Testing services to simulate the space/launch environment (e.g., thermal cycling, vibration)“ [1]

### Images and Videos

Small Satellites are a quickly emerging market so there is a large percentage of the community that is unaware of the existence of CubeSats. To help the public visualize CubeSats and to supplement the Small Satellites description there is a rotating digital carousel that depicts several images of Small Satellite Systems. These images include CubeSats being deployed in orbit, CubeSats ground testing, and other small satellites including PhoneSats. Figures 2a and 2b are screenshots of the images for the website of CubeSats undergoing ground testing and being deployed into Low Earth Orbit. At the bottom of the Small Satellite webpage there is an embedded YouTube video that discusses what engineering students and industry partners are currently doing to further evolve the CubeSat industry [2]. The video also contains an interview with one of the inventors of CubeSats, Dr. Robert Twiggs who is a professor of Space Sciences at Morehead University. Dr. Twiggs shares his experience with the initial stages of how and why CubeSats were developed. He shares his experience with incorporating a CubeSat program at Stanford University in 1995. He learned that if students were restricted to the size of the satellite then they would be able to quickly and inexpensively build small satellites that would be ready for launch faster than previously attempted.



Figure 2a CubeSats Ground Testing



Figure 2b CubeSats Deployed in Low Earth Orbit

Universities from all over the country are increasing their attendance at CubeSat developmental workshops where they can showcase their projects as well as collaborate with others. Many of the university team's projects are educational and designed to inspire children to learn more about the Science Technology Engineering and Mathematics (STEM) fields. The KSC Partnership website will guide the universities as they pursue future projects.

### Potential Services

Many universities and industrial partners are interested in analyzing their CubeSat's experimental data. These universities and industrial partners are either not able to or not interested in performing tests and procedures to ready their payloads for a flight opportunity. Kennedy Space Center through the SPLITS team would match KSC's personnel and facilities to assist in the design, analysis and testing process. The labs offer many other potential services aside from SPLITS-related services. A second goal of my project was to tour these laboratories in order to collect updated material and photographs for the KSC Partnerships website with another intern.

Kennedy Space Center has over 40 laboratories and test facilities that cover a wide range of fields in both physical sciences and life sciences. The developing external KSC Partnership website will guide prospective customers to services including the corrosion lab, prototype development, life sciences, and other facilities and personnel at KSC.

One example of KSC's unique expertise is the Corrosion Technology Laboratory. This laboratory provides a network of people, equipment, and facilities that offer services in all areas of corrosion for NASA and external customers. The Corrosion Laboratory is part of the Applied Technology Division within the Engineering and Technology Directorate at KSC. This laboratory focuses on consulting and testing services for NASA and external customers, applied research, developing new corrosion detection and control technologies, and investigating degradation in different environments. This lab support NASA, other government organizations, industry, and educational institutions. Figure 3 shows experimental equipment that accelerates the degradation of metals by subjecting them to salt fog which imitates atmospheric conditions along the coast. The Corrosion Lab also has UV corrosion testing capabilities that SPLITS can apply to small payloads in Low Earth Orbit.



*Figure 3 Accelerated Corrosion Laboratory*

Another facility is the Prototype Development Laboratory (PDL). The PDL is a team of engineers and machinists whose primary purpose is the design, fabrication and testing of prototypes, test items and test support equipment. The PDL supports the research and technology development laboratories at KSC and all of the major engineering programs and projects in development at KSC. The PDL also helps aid industry partners and universities in designing and fabricating small payloads and their components. The PDL has a long history of providing fast solutions to complex problems, helping customers process experimental data and integrate small payloads. The laboratory takes challenging problems and delivers complete, documented solutions. The PDL can also provide custom tools and equipment to help customers improve their projects. The laboratory is equipped with a state-of-the-art machine shop with Computer

Numeric Control (CNC) machining, welding & soldering, hydraulics fabrication, sheet metal fabrication, rapid prototyping (3D printing), composite materials lay-up, electrical fabrication, 3D digital scanning, and LabVIEW software programming. The designers and technicians provide manufacturing engineering services to engineers at KSC, other NASA facilities, and outside customers. Figure 4 shows a 3D model of the internal avionics of small payload that is being designed at the PDL for a high-altitude balloon launch. SPLITS can use the expertise of the personnel in the PDL to test avionics that are designed for future small payloads.

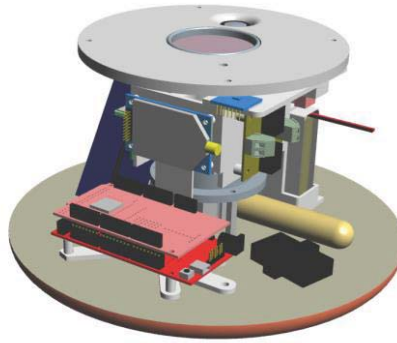


Figure 4. PDL Avionics 3D Model

### **Relevance to the NASA KSC mission**

It is Kennedy Space Center’s mission to safely manage, develop, integrate, and sustain space systems that enable innovation, access to space and inspires future explorers [3]. The SPLITS mission parallels KSC’s mission by assisting the growth of the space industry, and by guiding the development of spaceport and space technologies. In addition, the KSC Partnerships website that is under development will facilitate KSC’s mission by simplifying website so industrial partners and academic intuitions can identify personnel, expertise, and technical capabilities KSC can provide. Both the SPLITS line of business and the KSC Partnerships website will play instrumental roles in enabling our nation’s future explorers with greater access to space.

### **Conclusion**

Kennedy Space Center is sustaining current projects and fostering future NASA programs with diminished federal funding. SPLITS is an exciting endeavor to match KSC’s expertise in space exploration with potential commercial partners, academic institutions and other government agencies. In particular, SPLITS will assist providing services and launch vehicles for business that have interest in small payloads. SPLITS will also oversee the testing and integration of high-priority small payload technologies that require flight demonstration by preparing their payloads for flight opportunities.

The KSC’s Center Planning external partnership website which is under development will provide prospective partners with a one-stop portal to find services and personnel needed to access space. The KSC Partnerships website under development will help align the skills and talents of the KSC workforce and convey the technical capabilities that KSC offers.

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