

NanoLaunch

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Sponsoring Program(s)

Marshall Space Flight Center/Center Management and Operations
Center Strategic Development Steering Group,
Technology Investment Program, Center Investment Fund, Technology Excellence

Project Description

NASA's NanoLaunch effort will provide the framework to mature both Earth-to-orbit and on-orbit propulsion and avionics technologies while also providing affordable, dedicated access to low-Earth orbit for CubeSat-class payloads. The project will also serve as an early career personnel training opportunity with mentors to gain hands-on project experience.

NanoLaunch is a three-phase, high-risk research and technology development project that will focus on developing the insertion stages needed to place a nano-class payload (1–10 kg) in orbit. In addition, the project will design and build the test vehicles and avionics for the test flights. Phase 1 (FY 2013) developed and static fire tested an 8-lb motor as proof of concept of a fully printed solid rocket insertion stage. Additionally, avionics using an android cell phone and reaction control system (RCS) using a paintball canister was developed and tested on Phase 1 test vehicles (fig. 1). These vehicles are reusable, 4- and 6-in-diameter hobby rocket kits with commercial-off-the-shelf 'K,' 'M,' or 'O' booster motors and serves as hands-on training in rocket assembly and integration for the team (fig. 2). Phase 2 (FY 2014/2015) focuses on the development of a full-scale insertion stage avionics, RCS, separation system, and assembly and integration of a two-stage,



Figure 1: Local test flight of the Avionics and RCS on the NL1D ('Wildman' amateur hobby rocket kit w/M3400 motor).



Figure 2: Hands-on training building rockets.

9-in-diameter, reusable test vehicle. Phase 3 will utilize the phase 2 vehicle as the upper stage on top of a heritage sounding rocket configuration that provides a test-bed for suborbital and orbital capability for this class of payloads.

The current phase 2 vehicle, NL2A, is scheduled for its first flight in the spring of 2015. The NL2A is a two-stage, 9-in-diameter, carbon fiber airframe vehicle measuring 17.5 ft in length powered by an O-8000 booster motor. The 9M upper stage motor is an integrally over-wrapped phenolic tube and nozzle with printed forward dome attached to a loaded propellant cartridge (fig. 3).



Figure 3: Insertion stage motor, 9M.

The NL2A will demonstrate the manufacturing techniques of the 9M upper stage motor, provide a flight test opportunity for multiple nanolaunch-class vehicle avionics, and exercise the NanoLaunch team's ability to design, build, integrate, and fly a launch vehicle. The NL2A is co-manifested with payloads from NASA Ames Research Center (ARC), NASA Kennedy Space Center (KSC), and ATK. The NL2A project is providing test flight opportunities to ARC's Advanced Vehicle Avionics (AVA), KSC's Rocket University avionics package, and ATK's wireless sensors. NL2A is also utilizing the S-Band transmitter module of NASA Marshall Space Flight Center's (MSFC's) programmable ultra-lightweight system adaptable radio.

Anticipated Benefits

Anticipated benefits include flight opportunities for high-payoff technologies, orbital access for CubeSat-class payloads, and training for the next generation of rocket engineers, project managers, and chief engineers.

Potential Applications

The qualification, by flying on NanoLaunch, of these technologies and approaches will raise the competitive bar and increase the available alternatives enabling launch service providers to create and maintain an affordable launch service without having to take on the full development cost and risk. Within this paradigm, a new stage can be tested in flight within the scope and budget of a phase 2 Small Business Innovation Research (SBIR). Aggressive technology maturation raises the competitive bar, benefiting multiple programs like Airborne Launch Assist Space Access, NASA Launch Enabling eXploration and Technology, Defense Advanced Research Projects Agency, Operationally Responsive Space, and others. It also strengthens inter-Center cooperative competition, increases academic outreach, and improved SBIR/Small Business Technology Transfer focus.

Notable Accomplishments

This activity is providing hands-on training while at the same time placing MSFC in a lead role in the development of a robust NanoLaunch development system.

The NanoLaunch project successfully laid a path forward to enable the design, development, and testing of low-cost solutions to components and systems needed to reduce the cost of the NanoLaunch vehicle, including the capability of low-cost avionics components and an Android cell phone to track and telemeter data from the rocket, and the capability of a low-cost plastic 3D printed igniter assembly that utilizes a commercially available hobby rocket igniter motor.

An RCS was developed and tested, utilizing a commercially available paintball canister.

Additive manufacturing techniques needed specifically to build a flight weight insertion stage motor was developed.