Dual Spacecraft System

Roy Miller[1]
United Launch Alliance, Englewood, CO 80112

Abstract

United Launch Alliance (ULA) has many rideshare opportunities to offer to our customers, including two options for dual manifesting: Dual Spacecraft System – 4m payload fairing (DSS-4) and Dual Spacecraft System – 5m payload fairing (DSS-5). Two independent, similarly sized missions can fly on a single ULA launch vehicle, utilizing either our DSS-4 or DSS-5 payload adapters. DSS-4 and DSS-5 could fly atop an Atlas V or Delta IV launch vehicle. DSS-4 allows for the launch of two small-to- intermediate class spacecraft. It consists of two back-to-back Centaur Forward Adapters. The Centaur Forward Adapter is a flight-proven combination of a cylindrical adapter and a conical adapter attached together with a common ring. It flies today as the forward end of the launch vehicle upper stage. DSS-5 is larger than DSS-4. It will allow for two medium class spacecraft to launch on a single launch vehicle. It is a composite structure which is being uniquely designed to fly dual missions. It consists of a combination of an upper conical section and a lower cylindrical section. Like DSS-4, the DSS-5 will use a flight proven separation system.For both hardware options, the payload fairing completely encloses the DSS. The DSS encloses the lower payload and provides structural support for the upper payload; the DSS reacts loads from the upper payload during vehicle flight. The forward interface of either DSS is the 62 inch SIS payload interface, permitting use of existing payload adapters. The aft spacecraft interface attaches to the Atlas or Delta launch vehicle through a common SIS interface.In this paper, we discuss the advantages and benefits of dual manifesting missions. We compare DSS-4 and DSS-5 concepts, designs, configurations, maturity, and capabilities.

I. Description

The Dual Spacecraft System (DSS-4) is based on our existing Centaur Forward Adapter (CFA). The cylindrical and conical sections of the CFA are skin and stringer assemblies, joined together with a shared ring. The CFA is a structurally tested and flight-proven component. In order to create a DSS-4, two CFAs are taken and all non-essential and non-structural components are removed creating what are called canisters. These two canisters are then joined together to form a clamshell (Figure 1). If more volume is required by the lower spacecraft, it is possible to insert up to four stub adapter plugs between the two canisters. The stub adapter is the two-foot cylindrical portion of the CFA and can be seen in Figure 1. More details pertaining to the payload envelopes available can be found in the "Dual Spacecraft System (DSS)" paper presented at the AIAA Space 2008 Conference & Exposition.

[1] Senior Staff Mechanical Engineer, Atlas Payload Accommodations Structures, 7630 East Chester Street, Englewood, CO, 80112, AIAA Member

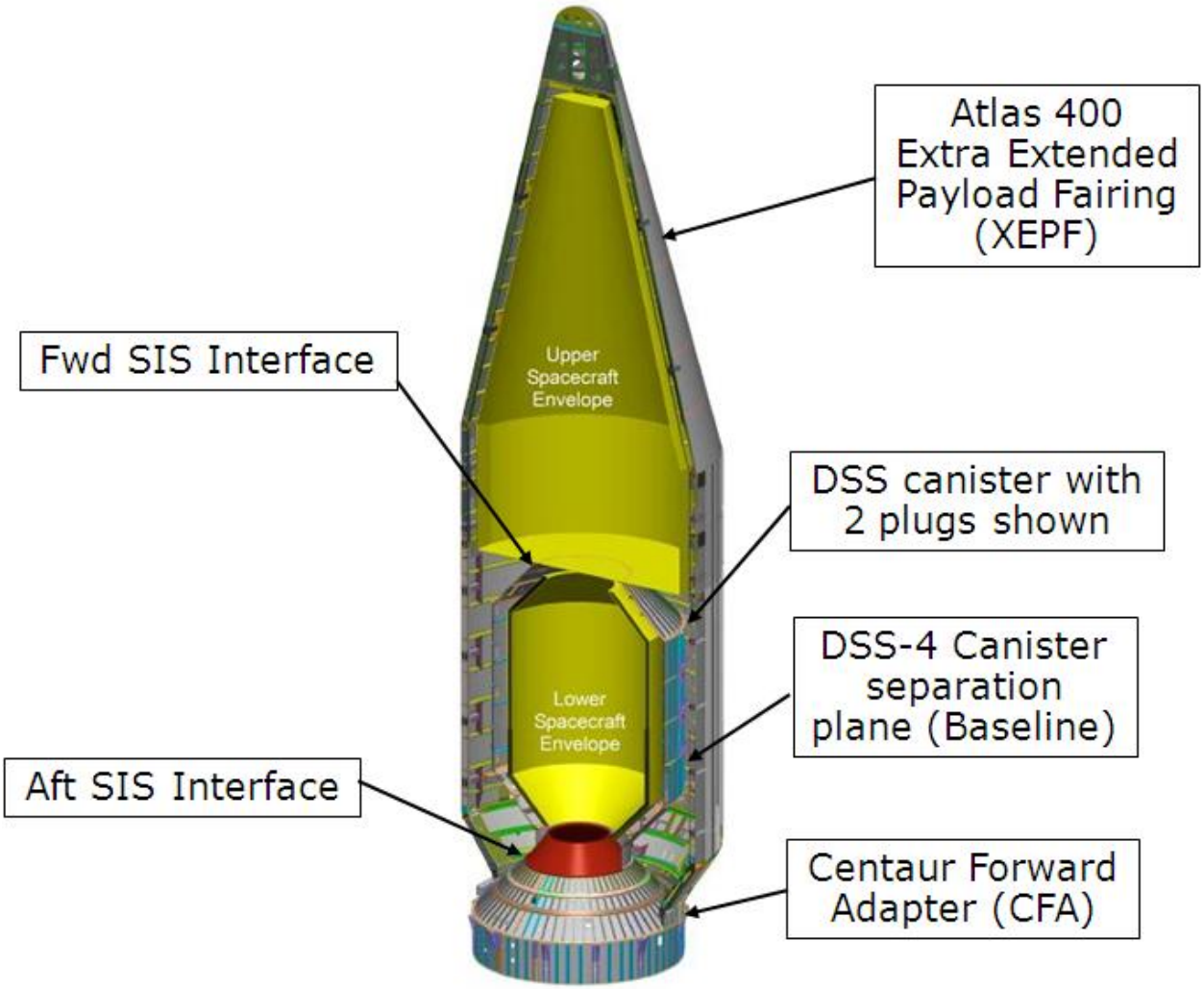

Figure 1: The DSS-4 inside the Atlas 4m fairing showing upper and lower envelopes

The DSS-4 concept successfully went through a Preliminary Design Review (PDR) in September 2008. The preliminary design of the DSS was presented before ULA management and potential DSS customers and was approved to proceed to Critical Design Review which was held in December 2009. Additionally, two separate Kaizen events were held. In October of 2008, the team went to Harlingen, TX to coordinate with Manufacturing in an effort to increase the producibility of the DSS. In June of 2009, the team went to the Cape Canaveral Launch Site to identify any potential roadblocks that may arise with the processing of two separate payloads. As we are not under contract for any specific missions yet, the review and Kaizen events were performed for generic payloads.

The DSS-5 is designed to launch two medium-to-intermediate class payloads. The DSS-5 is a newly designed (Clean Sheet) composite structure that can fly within an Atlas V or Delta IV 5-m payload fairing. The structure consists of a one-piece composite cylindrical canister and an upper cone structure, which is enclosed by the 5-m payload fairing. The DSS-5 encloses the lower payload and provides structural support for the upper payload. There is no change to the structural support of the lower payload. Loads from the upper payload are reacted by the DSS-5

during vehicle flight. The DSS-5 structure contains a ULA flight-provided separation system at the aft end to separate the DSS-5 canister from the vehicle after upper payload deployment. The DSS-5 also provides support for the ULA-provided electrical harnessing to the upper payload, instrumentation, and upper payload separation system. The canister will sit upon a truss assembly (Atlas) or composite adapter (Delta) that attaches to the launch vehicle. Trade studies are ongoing and the new design will be based on previously qualified rings, adapters and separations systems.

The basic composite shell of the DSS-5 will be a build to print design and manufactured by a supplier. The basic structure will be made of a vented honeycomb sandwich construction. The truss assembly will be composed of composite struts with metallic end fittings. Final assembly of the structure will be performed at the ULA manufacturing facility in Decatur Alabama. At completion of the manufacturing, the DSS-5 will be sent to the launch site for final integration to the launch vehicle. Trade studies and requirement reviews are currently being held to finalize the design concept. The system requirements will be documented in the Design Requirements Document (DRD) upon completion of the systems requirements review (SRR).

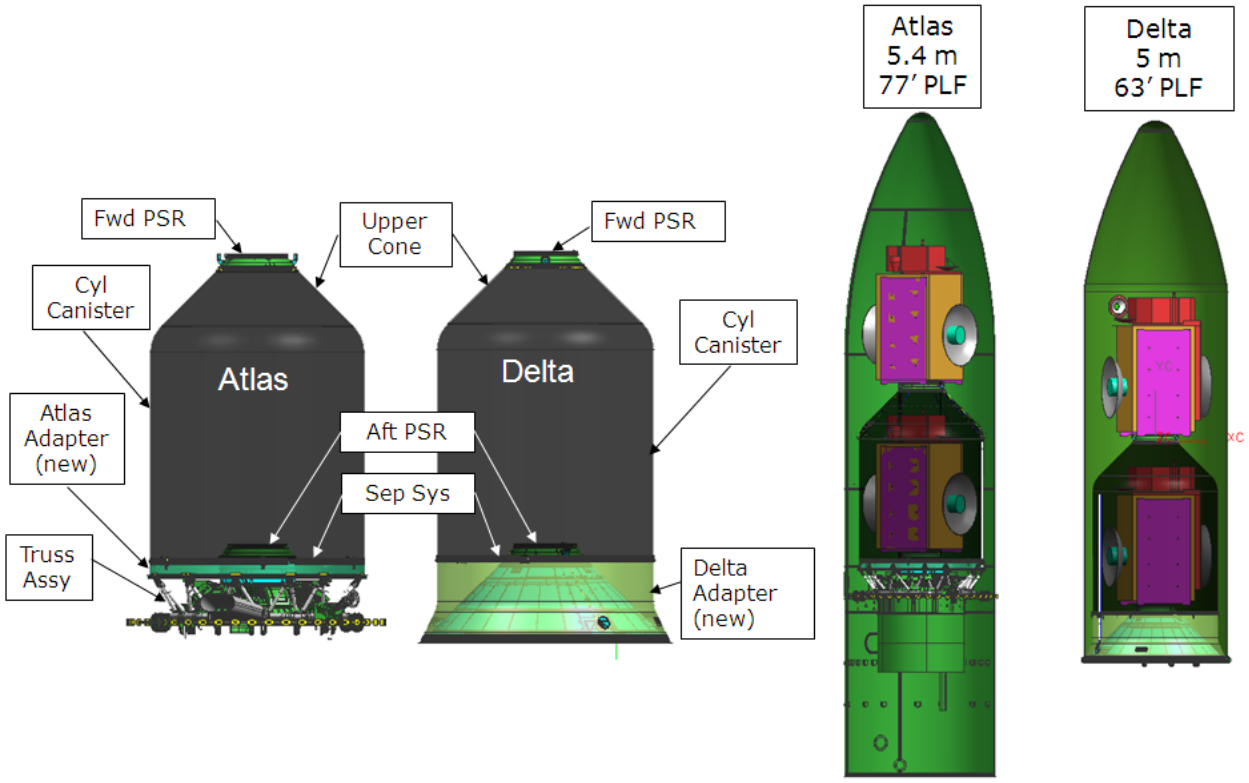

Figure 2: DSS-5 Configurations

The DSS-5 Payload "stack-up" begins by mounting the lower spacecraft and adapter combination to the base of the launch vehicle payload separation ring. An electrical verification test will be performed to assure that all connections are properly mated and all systems are functioning. When these tests are completed, the DSS-5 canister is placed over the lower payload.

Once the lower payload is encapsulated within DSS-5, the upper payload and its adapter are mated to the top of DSS-5. An electrical verification test is then performed for the upper payload to assure that all connections are properly mated and all systems are functioning properly.

Once the DSS-5 stack-up is completed, the dual-manifested payloads will be encapsulated within the launch vehicles 5-m-dia composite payload fairing. After encapsulation is completed, conditioned air is provided to the

fairing, to assure a thermally stabilized environment. The encapsulated payloads are transported to the launch pad several days before launch. At the launch pad, the encapsulated satellites are hoisted by a crane and mated to the top of the launch vehicle. Final connections are verified, and preparations are made for final countdown and launch. Conditioned air is provided to the payload bay on pad until launch.

II. Advantages to the DSS

The DSS-4 and DSS-5 will utilize many fight proven components which has advantages in development design cost, reliability and schedule. Many of the hardware components are already flight qualified and structural testing results are available, so the capabilities are well understood and known to be compatible with both launch vehicles and a large range of payloads. Development is simplified, production tooling exists, and nonrecurring costs and risks will be reduced when compared to those of a brand new development. A dual mission increases manifest flexibility and allows for additional spacecraft deployments for the same number of actual launches. The DSS-4 and DSS-5 are well poised to take advantage of the need to launch dual small to intermediate spacecraft. This class of payloads could find the ride-share opportunities presented by the DSS to be invaluable.

III. New and Updated Design Details

Since the Critical Design Review (CDR) of the DSS-4 in December 2009, the team has made significant progress in the design and analysis of the DSS-4. Many of the structural drawings are being completed and released along with the completion of the structural analysis report. Several customers have shown interest in flying their spacecraft in the DSS-4 in both the Atlas V and Delta IV 4-m and 5-m payload fairing configurations. Once a contract is in place, the DSS-4 will be manufactured at the ULA Harlingen Texas facility, then tested to verify design analysis. Upon completion of the testing, the DSS-4 will be ready for flight.

The DSS-5 is not as mature in the development cycle as the DSS-4. The DSS-5 project is in the requirements gathering phase with all of the design, analysis, manufacturing and environmental disciplines brainstorming design elements. The Systems Requirements Review (SRR) was held on 9/15/11, and trade studies performed to consolidate / optimize the design. After all of the requirements are gathered and vetted, the design concepts will be modeled to further the development of the DSS-5. Upon completion of the model design concepts, the development will enter the next phase which is Preliminary Design Review (PDR) which is planned for the end of 2011. This review will solidify the basic design configuration, materials and manufacturing methods.

IV. Conclusions and Future Work

The DSS-4 and DSS-5 represents a very cost effective opportunity for the small-to-intermediate class payload market. There are many advantages to using existing, qualified components from launch vehicles with proven track records, like the Delta and Atlas. Customer interest in both the DSS-4 and DSS-5 development and capability has been steadily increasing in this new budget conscious environment. ULA is also committed to dual payload development and is looking to bring this dual launch capability on line in the near future.