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Cygnus Payload Accommodations: Supporting ISS Utilization

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Cygnus Payload Accommodations: Supporting ISS Utilization

**Frank DeMauro
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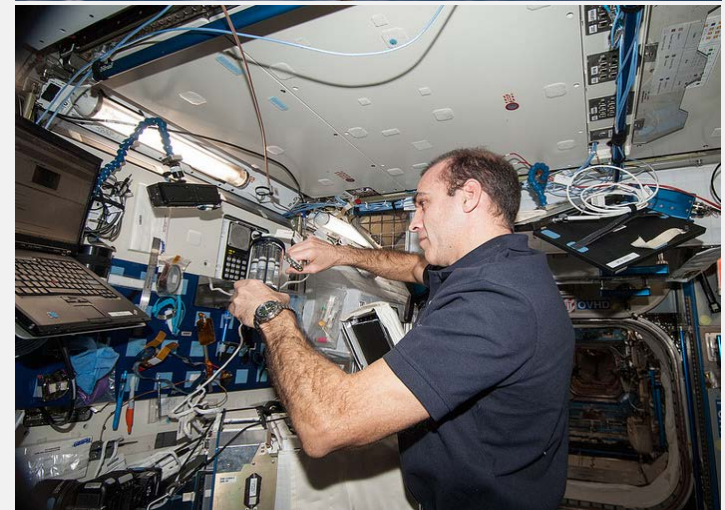
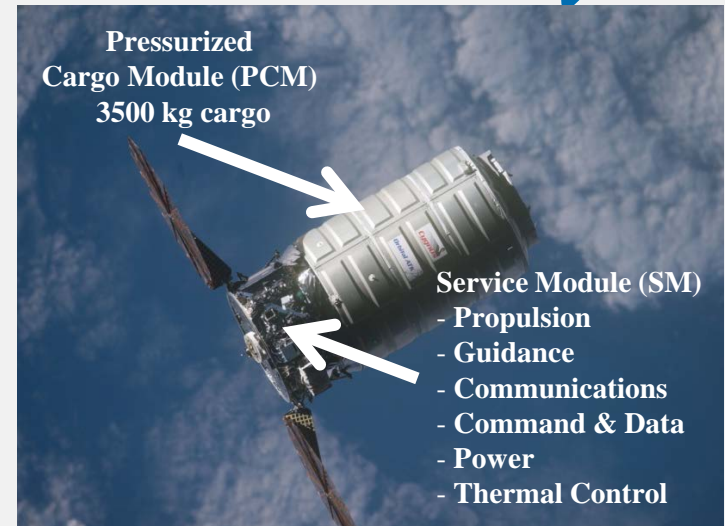
February 27, 2018



Cygnus Cargo Transportation Service to the ISS



- Orbital ATK is the prime contractor and developer of the Cygnus spacecraft, providing logistics support to the International Space Station (ISS) under NASA's Cargo Resupply Service (CRS) contract, including commercial and science payloads
- Cygnus is an advanced maneuvering spacecraft, incorporating elements drawn from Orbital ATK and its partners' existing, flight-proven spacecraft technologies
- It is a semi-autonomous delivery system for pressurized and unpressurized payloads and cargo, that meets NASA's human spaceflight rated vehicle requirements.
- The Cygnus system is a flight-proven, low-risk design with seven highly successful flights to date



Cygnus is an Evolvable Platform that can be Modified to Support a Variety of Payloads

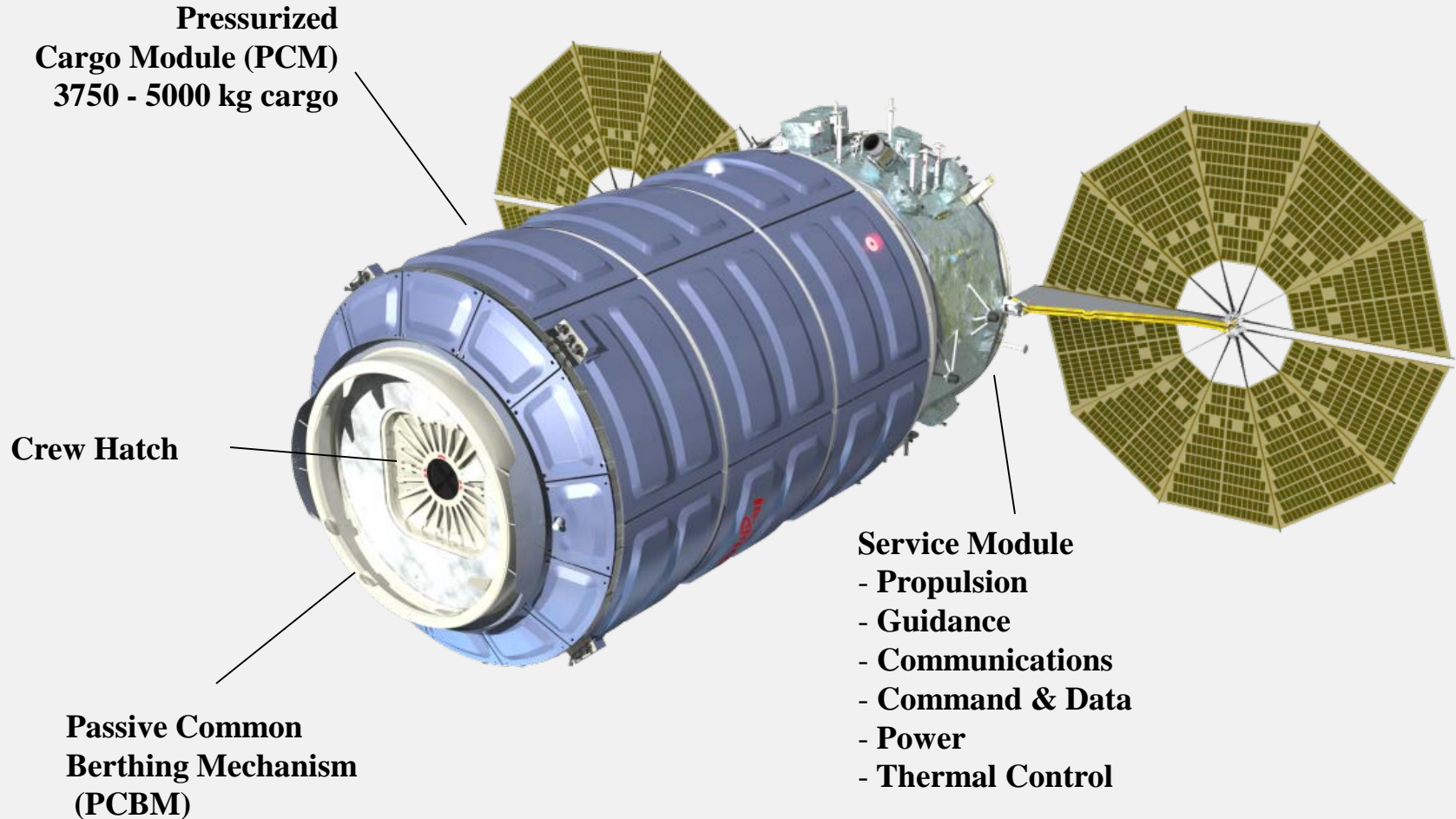
Cygnus Vehicle Overview



- The Cygnus Service Module (SM) is manufactured in the Spacecraft Manufacturing Facility (SMF) in Dulles, Virginia
- The Cygnus SM incorporates fully flight-proven avionics, propulsion and power systems.
 - Heritage of these systems with other Orbital ATK product lines provides for long duration operations of the Cygnus spacecraft in the deep-space environment (i.e. radiation)
- Cygnus has been launched by the Antares launch vehicle from the Wallops Flight Facility (WFF) in Virginia and Atlas V launch vehicle from Cape Canaveral, Florida
 - Antares is developed and operated by Orbital ATK, while the Atlas is contracted with United Launch Alliance (ULA)

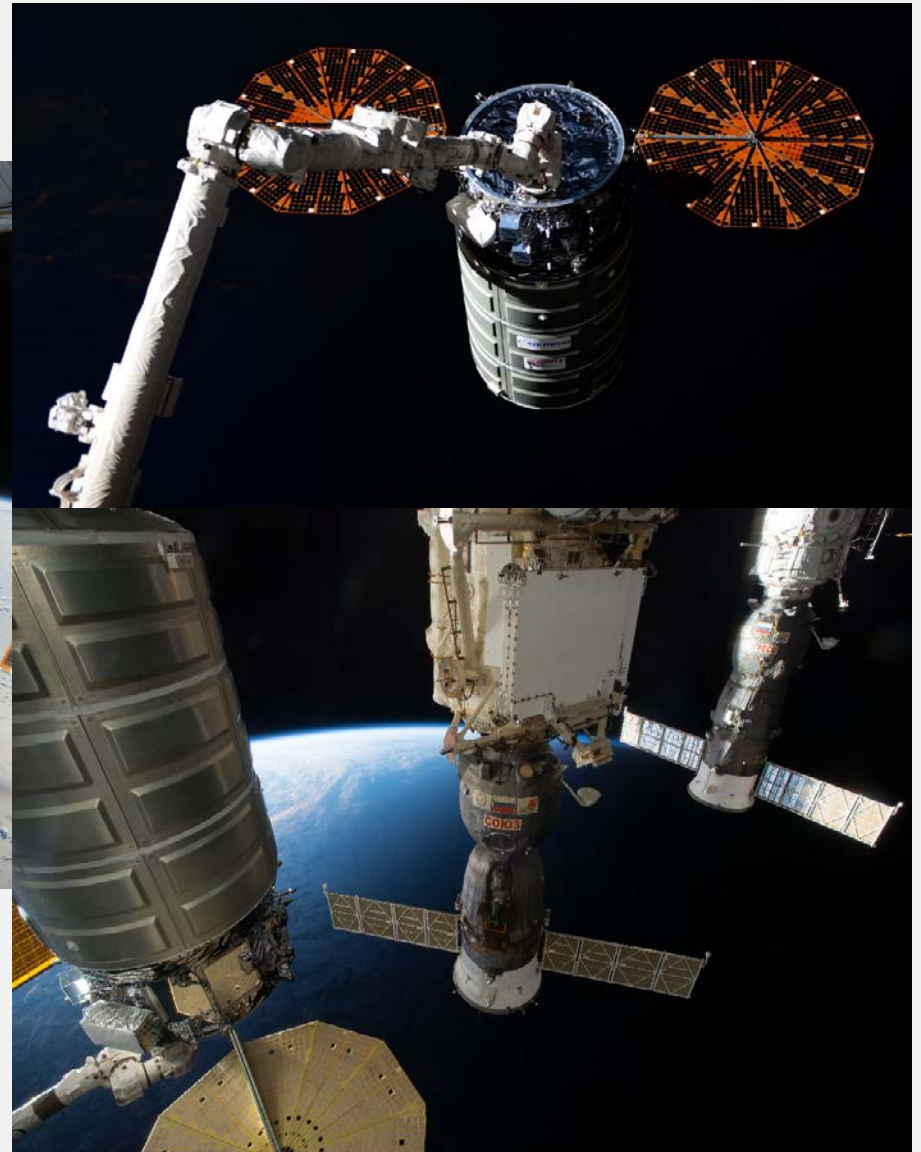


Cygnus Cargo Delivery Vehicle



Cygnus Has Delivered More Than 20,000 Kg of Cargo to the International Space Station

Cygnus Rendezvous and Capture

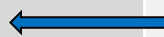


Recent and Planned CRS Missions



Mission	Current Launch Dates	Launch Vehicle	Current Delivered/ Planned Upmass (kg)
Successfully Completed OA-4	December 7, 2015	Atlas V	3513
Successfully Completed OA-6	March 22, 2016	Atlas V	3600
Successfully Completed OA-5	October 17, 2016	Antares	2425
Successfully Completed OA-7	April 18, 2017	Atlas V	3400
Successfully Completed OA-8	November 12, 2017	Antares	3350
OA-9	May 2018	Antares	3350
OA-10	October 2018	Antares	3350
OA-11	January 2019	Antares	3500

Long Duration Mission



Orbital ATK Will Also Conduct a Minimum of Six Missions on the CRS2 Contract

Cygnus Support to ISS Utilization



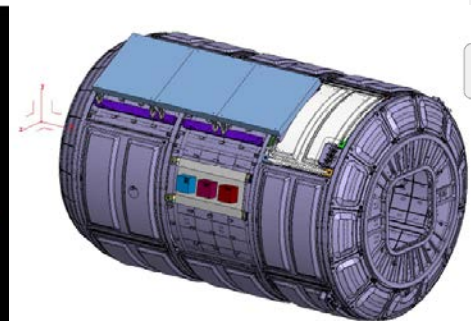
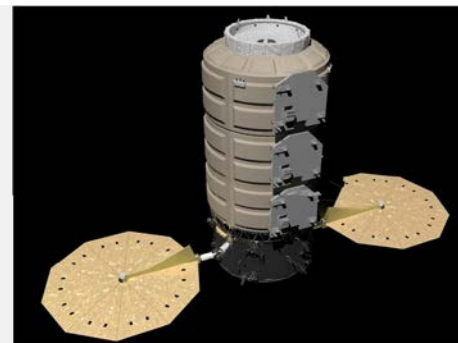
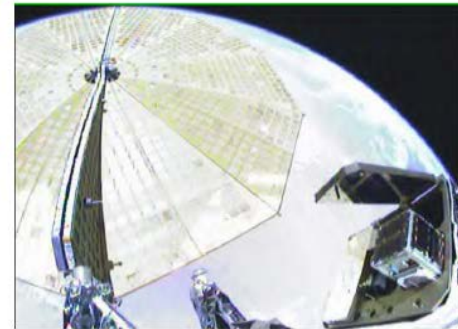
- Cygnus offers unique capabilities to ISS users beyond the normal-/routine cargo services
- Cygnus can provide unique environments for technology demonstration/testing and commercial payloads
- Following the normal cargo services to the ISS, Cygnus can use the remaining onboard propellant to achieve altitudes above the ISS for payloads such as CubeSat deployments
 - NanoRacks payload deployments at an altitude of 500 km have been demonstrated
- Accommodates payloads deemed too hazardous to ISS
 - Spacecraft Fire Safety Experiment (Saffire)
- Provide an autonomous platform for payloads desiring long duration, free-flyer and return to ISS
 - Potential for production of pharmaceuticals or special materials, etc
- The Cygnus spacecraft provides an operational capability that is available, versatile and affordable to a wide range of commercial and government customers



Cygnus Capabilities and Commercial Payload Accommodations



- Cygnus currently provides payload interface support in the areas of structure, power, commanding and data down-link
- Internal payload accommodations –
 - Cygnus can carry four to six powered Mid Deck Lockers (MDLs) for stowage or science experiments
 - Internal crew accessible volume
 - Various hard mount locations available
 - Ability to vary the internal pressure levels between 14.9 psi and vacuum
- External payload accommodations –
 - Standard External CubeSat Deployer Interface
 - Several external locations are available on the service module and PCM to accommodate unpressurized payloads
 - Provides good fields of view for instruments
 - Minimal interference from/with GPS antennas, communications, and thrusters



Future Cygnus Capabilities



- Capability enhancements and vehicle modifications are being developed to accommodate new commercial and government payloads
 - Enhanced interface services – power, data, communications
 - Unique micro-gravity environment
 - Long duration operations
 - Alternative payload deployment options
- Developing a “Cygnus Lab” platform for payloads
 - Extension of ISS science - increased number of MDLs
 - Long duration operations attached to the ISS with or without crew support
- Cygnus “free-flyer” capability that can support a variety of customers
 - Long duration undisturbed microgravity environment
 - Ability to hold attitude for specific ground target pointing or other payload objectives
 - Autonomous operations
 - Ability to return to ISS – allow for crew access to service or offload payloads

