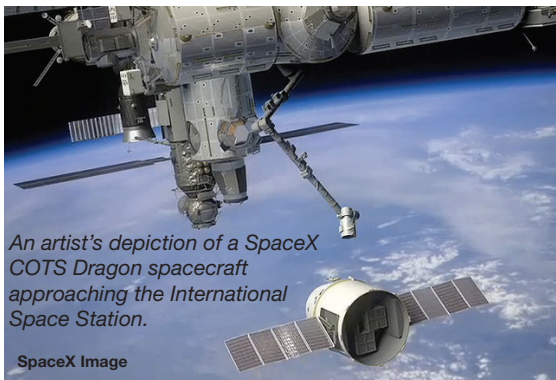




# Commercial Orbital Transportation Services Overview

Through a revolutionary program begun in 2006, NASA is investing financial and technical resources to stimulate efforts within the private sector to develop and demonstrate safe, reliable and cost-effective space transportation capabilities. This initiative is helping spur the innovation and development of new spacecraft and launch vehicles from commercial industry, creating a new way of delivering cargo to low-Earth orbit and the International Space Station (ISS).



As NASA sets its sights on exploring once again beyond low-Earth orbit, the ability of the private sector to provide routine access to space and the ISS is of vital importance. NASA's Commercial Orbital Transportation Services (COTS) program is the catalyst for this expanding new industry.

Under COTS, NASA is helping commercial partners develop and demonstrate their own cargo space transportation capabilities to serve the U.S. Government and other potential customers. The companies lead and direct their own efforts, with NASA providing technical and financial assistance.

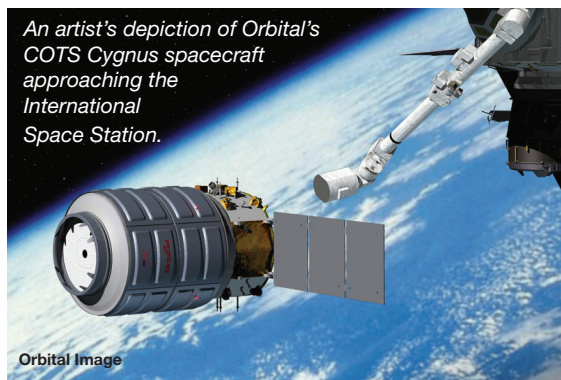
NASA is investing approximately \$800M toward cargo space transportation demonstrations. A unique aspect of the COTS program is that the

companies are paid incrementally as they reach certain milestones. This encourages steady progress toward their goals and reduces costs to NASA since the commercial partners are also investing company resources.

COTS was created with four different capabilities that companies could pursue:

- Capability A: External/unpressurized cargo delivery and disposal
- Capability B: Internal/pressurized cargo delivery and disposal
- Capability C: Internal/pressurized cargo delivery and return
- Capability D: Crew transportation (currently not funded under COTS)

Two companies have funded COTS agreements with NASA: Space Exploration Technologies (SpaceX) and Orbital Sciences Corporation (Orbital). Since their competitive selection, both have been working vigorously to develop technologies and capabilities to complete orbital space flight demonstrations. The ISS Program has already purchased future cargo delivery services from both companies to resupply the space station through 2015.



NASAfacts



## Orbital Sciences Corporation

Just 100 miles up the coast from where the Wright brothers first flew their airplane at Kitty Hawk, North Carolina, Orbital plans to launch its new COTS system at the Mid-Atlantic Regional Spaceport (MARS), located at NASA's Wallops Flight Facility in Virginia. Founded in 1982, Orbital's COTS system design is based on the new Antares rocket with a liquid oxygen (LOX)/kerosene (RP-1) first stage powered by two Aerojet AJ-26 engines. The Antares second stage uses ATK's Castor 30 solid-propellant motor derived from its flight-proven Castor 120. The spacecraft, known as Cygnus, is derived from Orbital's heritage DAWN and STAR projects and ISS cargo carriers. After delivering cargo to ISS, Cygnus destructively reenters Earth's atmosphere.

*An artist's depiction of the Orbital Antares rocket on the MARS launch pad at NASA's Wallops Flight Facility in Va.*

## Space Exploration Technologies

At Florida's Cape Canaveral, within sight of the launch locations of every NASA human spaceflight mission to date, SpaceX will launch its Falcon 9 and Dragon spacecraft. Founded in 2002, SpaceX has designed these systems from the ground up using the best of modern technology. The Falcon 9, which will launch the Dragon to low-Earth orbit, uses SpaceX-designed Merlin LOX/RP-1 engines, with nine in the first stage and one in the second stage. The Dragon spacecraft is designed to carry cargo to ISS and return cargo to Earth. In December 2010, during the first COTS flight, SpaceX became the first private company to successfully return a spacecraft from Earth orbit.



*An image of the SpaceX Falcon 9 rocket on Pad 40 at Cape Canaveral, Fla.*

## By the Numbers

Launch Vehicle	Orbital Antares	SpaceX Falcon 9
Height	40.1 m	48.1 m
Diameter	3.90 m	3.66 m
Mass at Launch	275,000 kg	313,000 kg
Payload to International Space Station Orbit	5,200 kg	9,800 kg
First Stage		
Thrust	3.27 MN (735,000 lbs)	3.80 MN (854,000 lbs)
Propellant	LOX and RP-1	LOX and RP-1
Second Stage		
Thrust	322 kN (72,000 lbs)	414 kN (93,000 lbs)
Propellant	Solid propellant	LOX and RP-1
Cargo Spacecraft	Orbital Cygnus	SpaceX Dragon
Height	5.1 m	5.9 m
Diameter	3.05 m	3.66 m
Maximum Pressurized Cargo		
Up Mass / Volume	1,700 kg / 18.75 m <sup>3</sup>	3,310 kg / 6.8 m <sup>3</sup>
Down Mass / Volume	2,000 kg / 18.75 m <sup>3</sup> disposed	2,500 kg / 6.8 m <sup>3</sup>
Maximum Unpressurized Cargo		
Up Mass / Volume	0	3,310 kg / 14 m <sup>3</sup>
Down Mass / Volume	0	2,600 kg / 14 m <sup>3</sup> disposed

Reflects proposed configurations of the early resupply missions to the International Space Station.

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